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Experts Comment on "A Critical Look at Salt Spray Tests"

New Drawing Brass Cuts Finishing Costs

Selecting Boron Steels by Hardenability

Technical Ceramics for Wear Resistant Parts

Black Oxide Finish by Chemical Dip Method

Fluorocarbon Plastics Bonded to Metals and Rubbers

Gold Scrap Recovery Methods

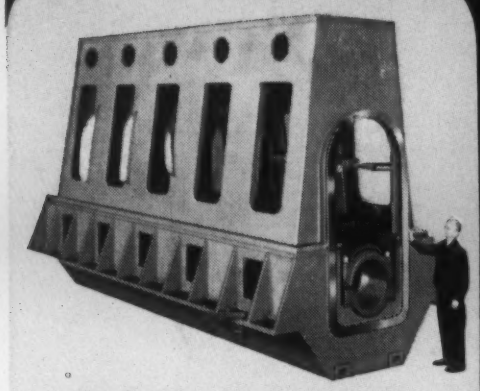
New Boron Steel Compositions

Boron Steel Hardenability Bands

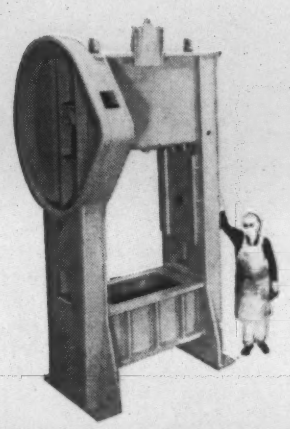
Materials at Work

HOW TO SELECT BRAZING AND SOLDERING MATERIALS
—Materials & Methods Manual No. 80

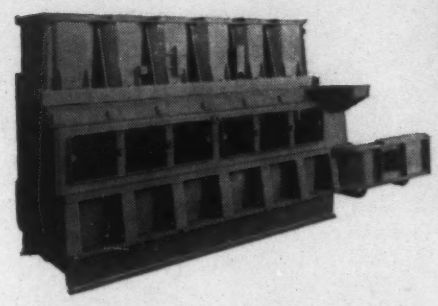
THE MAGAZINE OF
MATERIALS ENGINEERING
DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE



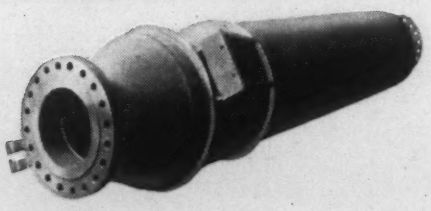
Crank Cases, Frames, and other Parts for Manufacturers of Marine Steam Engines of Uniflow or Multiple Expansion Type



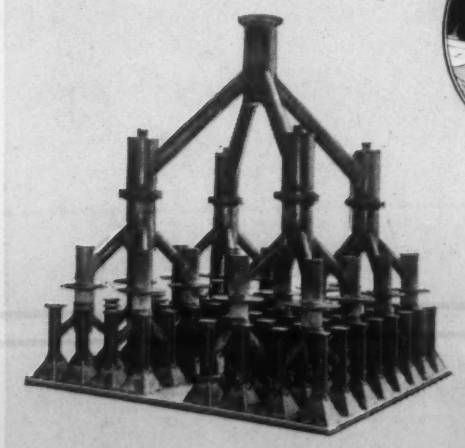
Heavy Press and Machine Frames and Bases for the Machine Tool Industry.



Diesel Engine Crank Cases and Frames for the Marine and Electro-Motive Field.



Pressure Vessels for the Chemical and Allied Industries.



One of Several Parts of a Catalytic Cracking Plant Produced for the Petroleum Industry.

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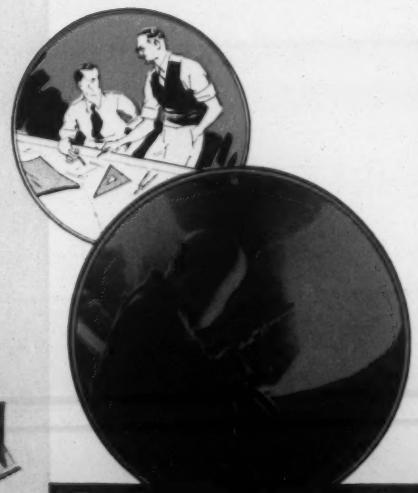

Mass production of these massive clutch and drive housings for a twenty-one ton tractor is further evidence of the design trend in modern machines . . . it is a typical example of how alert manufacturers are today employing Steel-Weld Fabrication to good advantage in the construction of their products. Thousands of such heavy machinery parts and assemblies are now produced and machined by Mahon for many manufacturers throughout the country. If savings in either cost or time can be effected in your product through Steel-Weld Fabrication of parts, or, if you are cramped for manufacturing space, it will pay you to investigate Mahon facilities. You will find in the Mahon organization an unique source with complete, modern fabricating, machining and handling facilities for any type of work regardless of size or weight . . . a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures you a smoother, finer appearing job embodying every advantage of Steel-Weld Fabrication.

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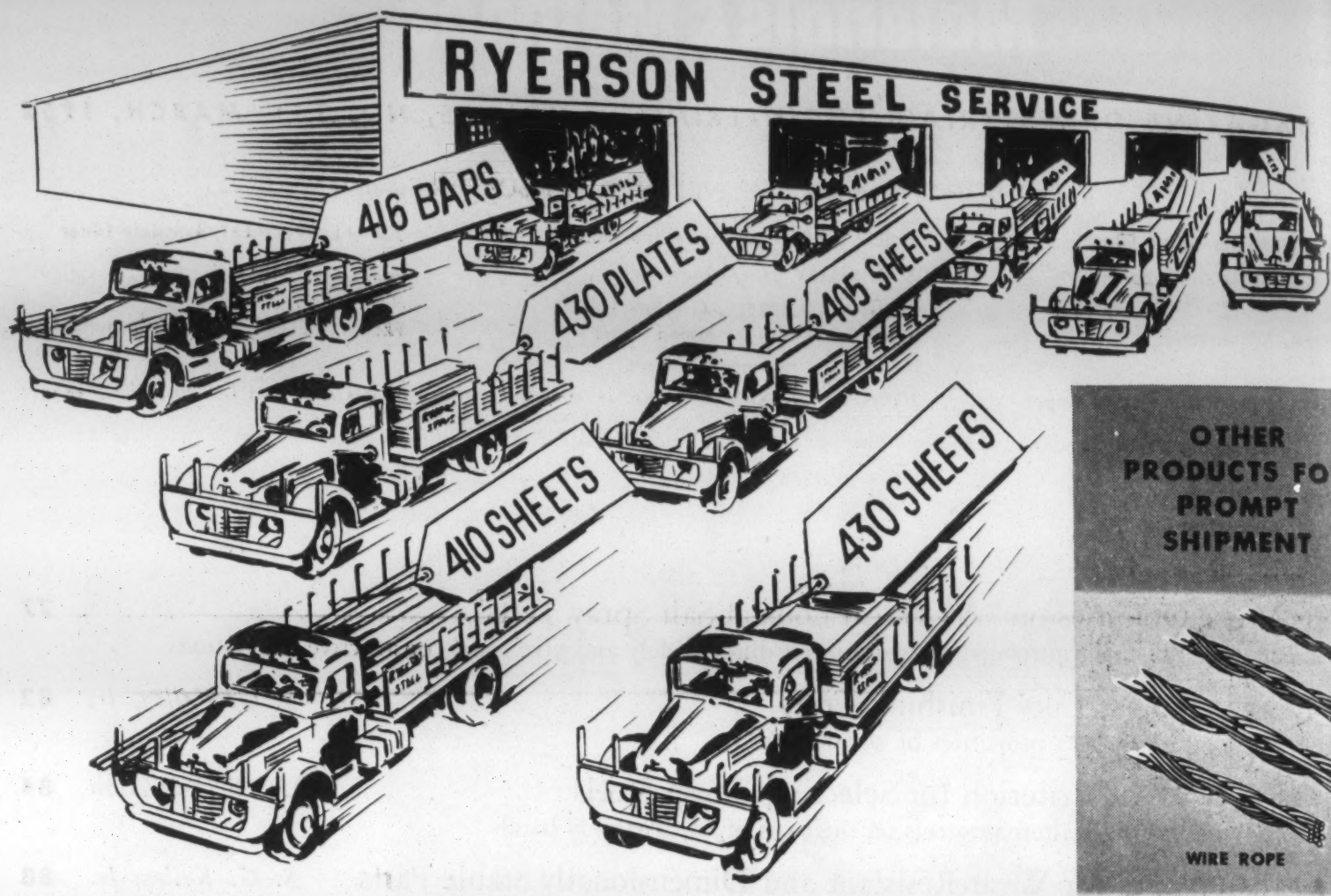

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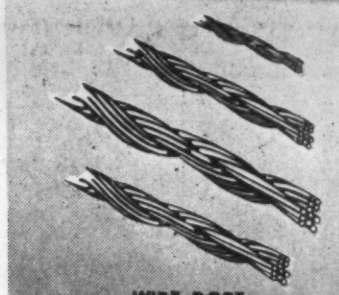
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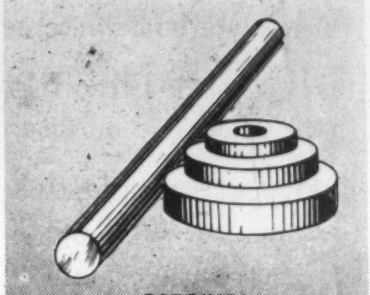
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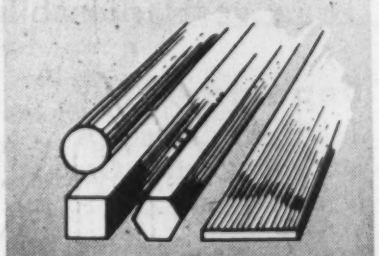
CARBON AND ALLOY CHAIN


TOOL STEEL, DRILL ROD

BABBITT METAL

The Materials Outlook

Several facts have begun to take shape in the materials picture for the automotive industry for the coming year. They seem to indicate a busy time for the materials engineer. . . . The industry's engineers think that so far the restrictions have not impaired the cars structurally. The appearance of plated parts has suffered, though. This is due to the shortage of nickel. . . . Many of the substitutions made or considered are more costly, or more difficult in processing, and require careful control in the plant. . . . Copper is the most critical material. It is used in the electrical systems of the cars, as an underplate, and as brass or bronze in bearings, bushings, and similar parts. Use of steel or aluminum, or a reduction in the amount of copper used, are being considered. Changing to a 12-v system from the present 6-v system would permit the use of smaller conductors. Disadvantages are that the smaller conductors would have poorer mechanical strength, and that considerably larger and heavier batteries would be required, with more lead. Plated steel and nylon are possible alternates for bearings . . . . Steel is in a class by itself. The amount available will probably determine the number of car units that can be built. . . . Cadmium has been eliminated from automobile bodies. Zinc plate is being used satisfactorily. Zinc in die castings may be replaced by plastics parts and steel stampings.

Rubber is being produced in record volumes. Stocks are soaring and price drops should be coming . . . . Natural rubber is coming out of the Far East as never before. Latin American plantations are also being developed. . . . One estimate is that 15% of the rubber produced in the world this year will pile up unused. . . . Akron people are forecasting an upturn in U. S. rubber consumption. They look for 450,000 tons of natural and 850,000 tons of synthetic to be consumed this year. Last year's figures were 454,000 tons of natural and 761,000 tons of synthetic.

A Soviet-licensed German news agency reports that Russian zone engineers have developed a plastic automobile body that is lighter than steel bodies but just as strong. The report notes that U. S. and British manufacturers had "tried for years" to develop a plastic body, "but without success."

A new silicone rubber compound developed by General Electric permits fabricators to mold silicone rubber parts easier and with highly improved mechanical and thermal properties. The new rubber is outstanding for its ease in processing. Fabricated parts have high tensile strength, high elongation, excellent electrical properties, and are serviceable over a wide temperature range (550 to −85 F). Many new applications, including diaphragms, boots, sleeves, belting, hose and mountings, are anticipated. . . . G-E, incidentally, plans to triple silicone rubber production.

(Continued on page 4)

The Materials Outlook *(continued)*

MIT researchers, working for the Navy, have developed techniques for forming large high-melting-point alloy parts by metal spraying. Dense hollow bodies can be made by spraying and sintering in hydrogen. Densification and removal of oxides is only feasible if a liquid phase of sufficient quantity is formed in sintering. This rules out pure metals. Another metal must be added to form a low-melting-point phase. . . . The general process is similar to powder metallurgy techniques and seems applicable to products that cannot be made as satisfactorily or as cheaply by casting, pressing or forging.

A new polyester film with high strength, heat resistance and insulating qualities has been developed by du Pont. It is not available commercially yet. The most promising application is electrical insulation. Industrial tape, packaging, collapsible tubes and light-weight storm windows also look possible. The film is transparent, retains its flexibility at low temperatures, resists chemical attack well, and shows high dimensional stability under heat and humidity changes. Its strength is 2 to 8 times that of present commercial films. The intermedite electrical polarity of the material permits it to store electrical energy, a requirement for condenser use.

Critical alloying elements were saved by General Electric by the development of low-alloy-ferrite steels containing chromium, molybdenum and vanadium. These show excellent strength at 1050 F and are being used extensively at this temperature for casings, piping and valves where high-alloy stainless steels formerly were used.

An example of material conservation and product improvement in the new Ford is the heater-defroster system. The heater core is 25% smaller than the 1951 heater and has 32% less copper, yet provides a 15% increase in air volume, temperature and over-all performance.

An improved liquid phenolic core binder resin has been developed by General Electric's Chemical Div. Designated as G-E 12353, it permits the molding of stronger sand cores than was possible with former phenolic resins, and has higher water diluteness and improved handling characteristics. Baking cycles are reduced to about one-half the time required for conventional vegetable or petroleum-base core oils. The improved binder also provides less sand burn-in on the casting, excellent collapsibility and easy shakeout. Low gas formation and high gas permeability result in sounder and smoother castings.

Molybdenum sulfide may be an effective lubricant in severe service applications. It prevents galling and seizing even with soft metals. It lubricates from −40 to +700 F. Main uses are in assembly parts, hot and cold metal forming, high and low temperature operating parts, and as a non-dust-collecting lubricant. Unlike graphite, it does not depend on a moisture film and can be used in a vacuum. It is also an electrical insulator. Since no free sulfur is present, it does not attack metals. In fact, it may even give some protection against corrosion.

(Continued on page 6)

Have you heard about

INCOLOY

(32 Ni.—21 Cr.)

...Inconel's high-temperature companion alloy

Designers know they can get good high temperature resistance and toughness in Inconel®. But NPA has forbidden its use in many applications.

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3. Strength at high temperatures.
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5. Fine welding properties.
6. Non-embrittlement.
7. Resistance to sulfidation, green-rot, and molten cyanide salts.

Incoloy is a *new*, specially developed alloy which is expected to be even superior in its resistance to sulfidation and green-rot as well as molten cyanide salts. And more important, its use is permissible in most applications covered in Schedule C to NPA order M-80.

Forms supplied — Incoloy is produced in the usual mill forms—billets, rounds, flats, hexagons, sheet and strip, tubing and wire.

Right now, Incoloy, like other Inco Nickel products, is on extended delivery because of defense needs. So it will pay you to place your order well in advance of anticipated production —be sure to include the necessary NPA rating with full end use information.

And remember, Inco's High-Temperature Engineering Section is ready to help you with your high-temperature problems. Write today for the specially designed High-Temperature Work Sheet to help outline your requirements.

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Continued from page 4

Newly-designed X-ray unit enables Fairchild Engine and Airplane Corp. to make rapid analyses of castings. Combination of a semi-automatic radiographic machine and an automatic film developer, the equipment produces a film a minute. The company is also experimenting with the use of a high intensity fluoroscope with sensitivities said to approach that of X-ray.

Materials Control Orders

A summary highlighting actions of the NPA affecting engineering materials during the period from Jan. 11, 1952 through Feb. 10, 1952.

● **CONTROLLED MATERIALS PLAN**

Reg. 1, Dir. 1, 9 to Reg. 1—The amendment to Direction 1, tightening the self-authorization procedure by which small users obtain steel, copper and aluminum has been clarified as follows: The amendment now permits any "Class B Product" manufacturer, commencing with the second quarter of 1952, to use self-authorization procedure to obtain controlled materials up to specified limits, provided, however, that he does not use it to obtain more than his average quarterly usage of such controlled materials during year 1950. Amount of nickel-bearing stainless steel which may be obtained during a quarterly period by self-certification reduced from 1500 to 500 lb.

Under Direction 9, non-nickel-bearing stainless steel removed from control, thus eliminating the requirement of CMP-4B tickets to purchase the metal. However, applicable provisions of M-1 and M-80 continue to apply.

● **ALUMINUM (Orders M-5, M-26, M-88)**

Aluminum producers can now place in production only ACM orders or orders scheduled under specific NPA direction. Importers are prohibited from selling aluminum excepting to fill ACM orders. Constituting an entirely new order, M-26 places restrictions on sale, delivery and use of packaging closures. For certain products, quota of aluminum closures is reduced from 65 to 35%. Packer may accept outstanding orders for aluminum closures even if they exceed 75-day inventory restriction. Permits packer to select quarterly base quota by weight of contained aluminum. An amendment to M-88 adds aluminum conductor wire and cable to the controlled materials list.

NPA announced that holders of CMP tickets for aluminum will be guaranteed positions on a mill schedule by the Aluminum and Magnesium Div., if unable to place orders.

● **BISMUTH (Order M-48)**

All limitations on use of bismuth, including type and quantity of use and the set-aside provision, are rescinded, as are inventory limitations of bismuth products excepting for anti-hoarding provision. Inventories of bismuth metal are relaxed from 45 days to a 60-day inventory, or a "practical minimum working inventory", whichever is less.

● **COPPER (Orders M-11, M-97)**

NPA announced that brass and wire mills may accept authorized ACM orders to the extent of 122% of current directive for acceptance and scheduling of orders, but the action does not alter provisions of basic copper order M-11. Definition of brass mill products is changed to include anodes, rolled, forged or sheared from cathodes. Under a new directive, means of self-certification are provided for distributors of copper foundry and copper powder mill products. Use of copper products in manufacture of electric lighting fixtures is limited to specific functional parts under new Order M-97.

● **IRON AND STEEL (Orders M-1, M-6A, M-47)**

Under Order M-1 as amended, production of iron and steel will be regulated entirely by directives or by production schedules authorized with appended CMP 4-B applications. At same time, Directions 1, 2 and 4 are revoked and Direction 3 is incorporated into amended order. Direction 1 to M-6A requires steel distributors to give preferential treatment to machine tool builders, military and atomic energy orders which can be filled from warehouse inventories. Order M-47 limiting use of iron and steel in manufacturing consumer durable goods has been revoked since it has been superseded by other NPA orders.

Anticipated Changes: Plans to differentiate tool steels from alloy steels in CMP orders are being developed.

● **RUBBER (Order M-2)**

The 30-day inventory limitation governing purchases of synthetic (GR-S) rubber has been removed but export restrictions on GR-S and the limitation on percentage of "cold" to "hot" GR-S which may be purchased continue. Same amendment increases amount of high tenacity rayon which may be used by rubber manufacturers.

● **NYLON (Order M-45)**

Plastic type nylon has been removed from allocation control.

● **TIN (Orders M-25, M-26)**

Constituting a complete revision, amended Order M-25 increases weight of tin coating permitted on cans for certain products, tightens the "25o base box" provision, and restores certain can quotas. An entirely new Order M-26 places restrictions on sale, delivery and use of packaging closures, specifying maximum tin coatings.

News about

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Geon Resin 404 excels in rigid applications with a wide range of uses

YOU wouldn't have guessed a few years ago that there would be a *high molecular weight* vinyl chloride resin that could be processed without plasticizer on standard equipment—mills, extruders, calenders. It's here today—Geon 404, especially designed for rigid applications.

Pictured here is corrugated translucent paneling material, made by laminating and molding sheets calendered from Geon 404. The panel is decorative, light, yet strong and durable. Color possibilities are unlimited. It can be wiped clean with a cloth and, of course, it's *fire resistant.*

Sheets, rods and tubes made from Geon 404 can be sawed, drilled and machined on ordinary wood and steel working machines. They can be readily welded in fabricating finished products.

Geon 404 has many uses. Processed without plasticizer, it has better chemical resistance than plasticized vinyls. It is finding many uses in industries where resistance to chemicals and corrosion is necessary, such as chemical processing, rayon, beverages, plating and foods. Its electrical properties are superior to those of standard plasticized vinyl compounds.

Geon 404 is a promise of an even greater future for the vinyl plastic family in variety of materials and expanded uses! For complete information on Geon 404, please write Dept. GO-2, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco.

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GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

BUSINESS IN MOTION

To our Colleagues in American Business . . .

Revere began to make aluminum extruded shapes in 1922, and hence has had thirty years of experience with the metal. During those years it has gained invaluable experience, and has installed new equipment in order to expand the list of aluminum mill products it offers to industry. This expansion has been conducted at an accelerated pace during the past ten years. Today it may come as a surprise to some people that Revere's present installed capacity makes it the largest independent fabricator of aluminum in the United States.

Revere is sometimes asked why we should have sought the same position in aluminum alloys that we occupy in copper and copper-base alloys. The fundamental reason is a simple one: we wished to increase our service to industry, which is demanding more and more metals of every kind. Thirty years ago we recognized the growing importance of aluminum, and we also perceived that aluminum and copper are in many ways complementary metals. Being able to offer both means that Revere can be impartial in recommending the one most certain to give the best results in a given application.

So successful has been our experience with aluminum that we are now pursuing a comprehensive program of expansion in regard to it. In one of the Revere plants in Baltimore, new aluminum rolling mills and annealing furnaces were installed before Korea, making possible tripled production of coiled sheet. Right now, in another Revere Baltimore plant, new extrusion presses and draw benches are being put in place. Equipment for the production of aluminum coiled sheet was installed in our Detroit plant over a year and a half ago. In about a year, the Los Angeles mill, now working with copper and copper-base alloys only, should begin to produce aluminum tube and extruded shapes in both the heat-treated and non-heat-treated alloys.

These plans to increase materially the Revere output of aluminum mill products will make them more quickly and easily available in various industrial centers. Here is evidence of our belief that the future of aluminum is as great as that of copper. Each has its place, in peace as well as war.

Revere's thirty-year growth in aluminum is in the American tradition of freedom to seek new ways to serve customers. It is typical of the business world, for in many thousands of companies the original products or lines have been expanded to include more or less related items. So we suggest that no matter what you buy, you ask your suppliers if they have other materials or products that would be of value to you. The more you know about what your suppliers make, the greater the possibility of improving your products or productivity.

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News Digest

Solar Remelts Scrap to Save Critical Alloys

Worker in Solar Aircraft Co.'s stainless steel foundry throws deoxidizer into furnace just before molten stainless steel is poured. The foundry, at Solar's San Diego plant, is profitably saving tons of critical alloys and is the company's main source of stainless steel castings, produced from re-melted scrap.

How to save tons of critical alloys during the acute metal shortage —and make a profit doing it—is being demonstrated by Solar Aircraft Co.'s San Diego plant. Solar is doing the job with a stainless steel foundry.

In 1946, Edmund T. Price, Solar president and general manager, conceived the foundry as a means of product diversification. Plants in the aircraft industry, as a byproduct of their operations, normally generate great quantities of scrap metal containing such scarce constituents as nickel, tungsten, chromium and columbium. This scrap is usually sold to metal dealers. Price decided to experiment with the possibility of remelting the scrap and producing the high alloy castings needed on the company's production lines.

Although ordinary iron castings are made in great quantities throughout industry, pouring aircraft quality castings of stainless and other high alloy steels is a much more difficult process. By evolving a number of new casting techniques, however, Solar solved the problems and now produces housings, flanges, casings, and other parts that would otherwise have to be made of forgings, which are more expensive.

More than 75% of the metal used to make stainless steel castings at Solar has come from the plant itself, in the form of small scraps from the cutting and trimming departments. The balance, required to adjust the melt so that the result will have the right chemical composition, consists of raw ferro alloys.

In the manufacture of stainless steel exhaust manifolds, jet engine components, and other aircraft parts, there is unavoidably a high percentage of waste metal. From the time a sheet of metal enters the plant until a finished product emerges, it is estimated that the various metal working operations result in discarding over 25% of the metal in the form of cuttings, blanked pieces and turnings. For greater efficiency, scrap of certain types from the production departments at Solar is gathered in color-coded barrels and delivered directly to bins in the foundry, where it is cleaned and remelted.

Having its own stainless steel foundry has provided many benefits for Solar. It provides the company control over delivery schedules, priorities and quality; it has simplified the metal salvage problem; and having foundry know-how in its own plant results in better design of Solar products involving castings. Since the foundry must compete for Solar business just as any outside supplier does, its prices and delivery dates must be at least equal to those of outside foundries. This competition acts to reduce the cost of Solar's products.

SPI Surveys the Reinforced Plastics Industry

The Society of the Plastics Industry, in looking back over 1951, has given out a resume of the reinforced plastics industry, with particular reference to the future prospects.

While all use of plastics resins—phenolics, melamines, silicones, epoxys, alkyds, cellulosics, polystyrenes and polyesters—when combined with different types of fibrous reinforcement—cotton, rayon, nylon, glass, paper, etc.—come under the general heading of reinforced plastics, the industry bases its own statistical picture on the use of polyester

(Continued on page 10)

resins with fibrous glass reinforcement. This is the section of the plastics industry that used to be called low pressure, because these were the first resins that would mold at very low pressures and with the use of little or no heat.

In the reinforced plastics industry, there are no big independent units. From coast to coast, there are approximately 30 companies engaged in reinforced plastics exclusively as custom component makers. In addition, there are proprietary companies such as those engaged in fishing rod and boat manufacture. A really big operation in molding reinforced plastics today would not represent a volume of much over one million dollars per year.

This is a business that is bound to become big. These materials do not compete with other plastics but rather with metals, wood, glass and other structural materials.

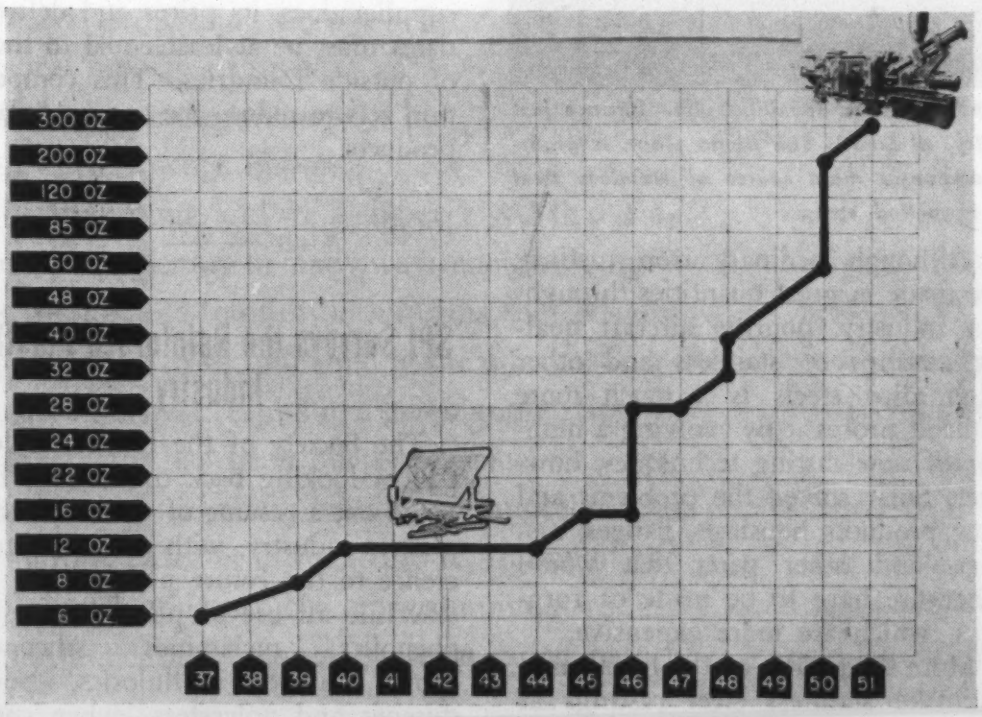
In 1950, sales of polyester resins from nine major makers and some smaller ones amounted to between 8 and 9 million lb; and with these resins was used between 4 and 5 million lb of fibrous glass. In 1951, resin volume was between 13 and 14 million lb, with more resin makers in the picture. Sales of fibrous glass for reinforced plastics were over the 7-million-lb mark because, particularly for military applications, there is a growing trend toward cutting the resin portion of the old two-to-one resin-glass ratio.

Resin capacity increased considerably in 1951, and further production is due to come this year. If all facilities suitable for polyester resin production were to be used, the industry could probably supply at a rate of 24 million lb per annum today, and by the end of 1952 should be able to produce at better than a 27-million-lb rate. Major companies concerned are American Cyanamid Co.; Pittsburgh Plate Glass Co.; Rohm & Haas, Inc.; Bakelite Co., Div. of Union Carbide & Carbon Corp.; U. S. Rubber Co.'s Naugatuck Chemicals Div.; Interchemical Corp.; Atlas Powder Co.; Plaskon Div. of Libbey-Owens-Ford Glass Co.; Marco Chemicals, Inc.; Ferro Enamel Corp.; and Shell Chemical Corp.

On the glass side of the picture, current expansion is at a terrific rate. Owens-Corning Fiberglas Corp. alone will have, by May of 1952, an installed capacity triple that which it had in early 1951, that new capacity alone being more than the present rate of the entire fibrous glass industry. Besides Owens-Corning Fiberglas, there is Glass Fibers, Inc. and Glass Floss Corp., who have been in the business for some time. Newly added and soon to come into production is a fiber glass division of Pittsburgh Plate Glass Co., and one of Libbey-Owens-Ford Glass Co. Perrault Brothers and Ferro Enamel Corp. are two more in the field, Ferro being a new facility.

Many fibrous glass facilities can be switched quickly from mat, to rovings, to yarn, to monofilament, so that regardless of other uses for fibrous glass, plenty should be available for use in reinforced plastics.

From a present use of less than 1¼ million lb per month of polyester resins in reinforced plastics, a growth to a 2 or 2¼ million-lb per month rate is entirely possible within the next few months. As metals become even shorter in supply, the reinforced plastics are receiving a lot of attention as materials for the manufacture of garage doors, construction units, oil transmission pipes, automobile bodies, refrigerator interiors, factory glazing—all this aside from the big military development programs which involve a variety of reinforced plastic pipe, ordnance components, aircraft wings, radomes, landing craft and several other kinds of boats, and body armor, to name a few. One program alone—the pipe program—could quite conceivably consume 10 million lb of polyester plastics per year.



Trend Is To Bigger Plastic Injection Moldings

The trend toward larger plastics injection moldings is indicated by the increase in size of machines produced in the last 15 years. This graph, supplied by the Watson-Stillman Co., of Roselle, N. J., shows how the maximum capacity of injection molding machines in commercial use has gone up. Even larger machines are contemplated.

Titanium Suggested as Aluminum Substitute in High-Speed Aircraft

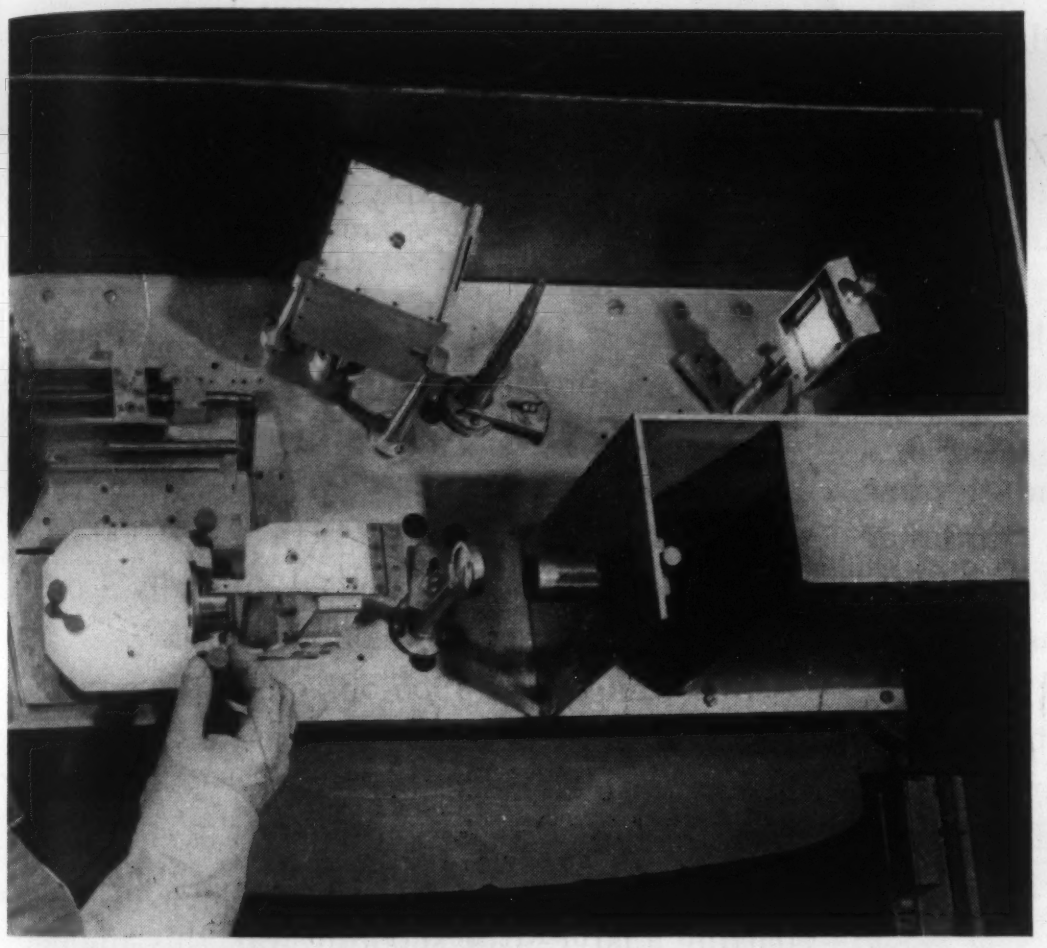
Some metal other than aluminum alloy will have to be used in planes if they are to fly faster than 900 miles an hour at sea level or 1200 miles an hour at 35,000 ft, declared Edward H. Heinemann, chief engineer of Douglas Aircraft Co.'s El Segundo (Calif.) plant. Mr. Heinemann suggested titanium was one of the metals that could solve the problem of high-speed flight.

The reason aluminum cannot be used is that at 200 F, which is the heat generated by skin-friction at these speeds, aluminum begins to lose its strength, Mr. Heinemann said. He added his firm had already made some small components of titanium, but said that it was too expensive for large-scale use yet. He declared that

stainless steel also might be used in an effort to lick the heat problem.

The Douglas engineer said he thought our military aircraft in general were becoming too complex. He cited this as one reason why our production effort has been lagging. He said this complexity, which arises from the use of radar, electronic controls and similar equipment, had been underestimated at the beginning of the build-up after the Korean War began. He said another reason for the lag in production was the slowness in the manufacture of components such as engines.

Mr. Heinemann said he believed that Russian aircraft, such as the MIG now used in Korea, are more simply built than our planes.



The Profilograph being used to measure smoothness of a metal surface.

Timken Machine Measures Surfaces to Within One Millionth of an Inch

How do you go about measuring the smoothness or roughness of a highly polished steel sphere or cylinder? How can you tell whether a machined steel circle is a perfect circle or not? Some time ago The Timken Roller Bearing Co. developed a machine which could determine with extreme accuracy just how rough or how smooth a steel surface was. Just recently, Timken Co. engineers have added a further refinement to this machine. With this new development, it is possible to determine if a ground circle is perfect or not. Both surface finishes and geometry are checked within a millionth of an inch.

The name of this machine that can measure accurately to within a millionth of an inch is the Profilograph. This development was directed by the Experimental Engineer for The Timken Roller Bearing Co.

The surface of the object to be measured is mounted on a flat delicately adjusted table which is fitted into a special bearing. A highly refined hinge is mounted just above the specimen for measurement. At the end of this hinge is a diamond needle and a tiny mirror. The diamond needle traces lightly over the surface of the object as the complete table upon which the specimen is mounted turns. As the needle rides over the surface, any variation in that surface wiggles the needle, and also the tiny mirror mounted on the same hinge as the needle. A tiny beam of light is played on the mirror and as the mirror moves, the beam of light moves also. Through a series of other mirrors, the light beam is transmitted onto a photographic film and the variations on the surface of the object being measured are recorded on a circular film. By changing the length of the light beam, surface variations can be magnified up to 5,000 times their actual size.

Huge Extrusion and Forging Presses Coming

The U. S. Air Force, Congress and the aircraft industry have gotten together on a program to build and install heavy extrusion and forging presses to make aluminum structural parts for airplanes. Structural members can be made quicker and cheaper by these presses than by conventional composite methods.

The Germans, and later the Russians, were interested in big presses. American aviation people saw the production, cost and performance advantages of large extrusions and forgings as early as 1945. The holdup has been the cost of the presses themselves. Right now the applications of such monsters would be confined to aircraft parts, and both industry and the military felt that previous airplane production planes would not justify the investment. Congress has now made the decision, however, and $210 million has been appropriated for the program. The Air Force will retain title to the presses, distributing them to manufacturers on a loan or lease basis.

Nine heavy forging presses are planned. Two of these will have capacities of 50,000 tons. The others will be somewhat smaller. One of the big forging presses will be delivered in 18 months, the other in 2 years. Plans for a 75,000-ton forging press were scrapped for the present because of costs. Aviation engineers think the price is secondary on the 50,000-ton presses, though. They feel that heavy aluminum structural forgings are neces-

(Continued on page 13)

A Statement by Anaconda on the Copper Situation

MANY users of copper have vital decisions to make . . . usually in connection with the present defense-induced shortages of copper and aluminum. This statement is an effort to remove the smoke screen surrounding the copper picture . . . to wipe away the confusion caused by too much talk supported by too few facts.

Substitution poses problems – Industry has been urged to substitute aluminum and other materials for copper. In some instances this may be logical and practicable. In many others it is difficult, if not impossible. But – before making *any* long-term decisions that may cost a great deal of money in engineering, new plant facilities or rescheduling of production operations – one should know the facts about the future of copper.

New Anaconda projects – The first major increase in copper production will come from Anaconda when the Greater Butte Project and the new Sulphide Plant at Chuquicamata, Chile, begin operations this spring. By 1953, these two projects should raise present levels of copper production by about 95,000 tons yearly.

Toward the close of 1953, Anaconda's new Yerington project in Nevada is expected to start producing at an annual rate of 30,000 tons. By then, Anaconda will be adding to the present yearly copper supply at the rate of about 125,000 tons.

Other new projects – During 1954-55 still other new projects in the U. S. and friendly foreign countries will further augment the increasing copper supply. All told, it is estimated that by 1955, not less than 450,000 tons of copper could be produced annually – over and above present production levels.

Accordingly, in 1955-56, domestic production plus imports could bring the U. S. copper supply to 1,800,000 tons yearly. This would represent an increase of about 20% over present levels. Based on historical comparisons, and barring a large-scale shooting war, this amount of copper could support a Federal Reserve Board Index of Industrial Production of 270, an increase of 24% over the present, and 45% above the first half of 1950.

• • •

These are the 'things to come' in copper. On the basis of the facts there is no necessity for considering long-range substitution of other materials for the red metal.

52320A

ANACONDA
COPPER MINING COMPANY

The American Brass Company
Anaconda Wire & Cable Company
International Smelting and Refining Company
Andes Copper Mining Company
Chile Copper Company
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PRODUCERS OF: Copper, Zinc, Lead, Silver, Gold, Cadmium, Vanadium, Superphosphate, Manganese Ore, Ferromanganese.

MANUFACTURERS OF: Electrical Wires and Cables, Copper, Brass, Bronze and other Copper Alloys in such forms as Sheet, Plate, Tube, Pipe, Rod, Wire, Forgings, Stampings, Extrusions, Flexible Metal Hose and Tubing.

News Digest

Continued from page 11

sary if the performance of combat jet planes is to be improved as much as seems necessary. The thinner wings required for higher, supersonic speeds can only be turned out with forged members. The forging monsters also look like the best bet to increase production to meet new plans. Short production runs on an 18,000-ton press now in operation give a good indication of this. One airplane used to require 30,000 milling machine hours. Up to 50% of this time and labor can be saved on the 18,000-ton press.

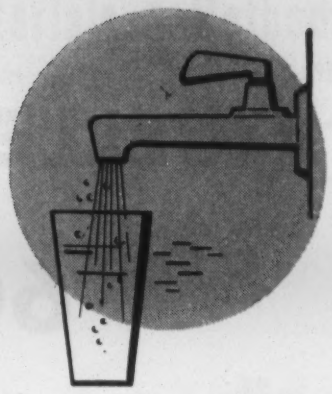
The extrusion presses will be somewhat smaller, on the average. They promise equally big advances, though. Eleven heavy extrusion machines will be built under the new program. One of these, a 13,200-ton machine, is now being installed by the Aluminum Co. of America. It will be ready in one year. This will be the biggest extrusion press in the country. The Reynolds Metals Co. has on the way two extrusion presses—one rated at 8000 tons, the other at 12,000 tons. The new Reynolds presses will be capable of exerting pressures far beyond the maximum of present equipment, which is 5500 tons. For example, the 12,000-ton unit will be capable of working an aluminum billet 32 in. in dia., 70 in. long, weighing 5000 lbs. A press of this size will make possible the extrusion of much larger parts. This will eliminate joining problems now encountered in making up equivalent assemblies of smaller parts.

Alcoa is more specific in talking about its new capabilities. Ribbed airplane wing panel extrusions, for example, may be made in lengths up to 90 ft. Ribbed panel extrusions of such size and shape mean that a plane may have a stronger skin with less weight. The wider shapes also reduce weight and production costs by reducing the number of rivets needed.

Alcoa also notes that its new press is by no means restricted to aircraft parts. It is possible to produce large strong-alloy shapes for the aluminum-conscious marine industry, for example. Large shapes for railroad car, bus, truck and trailer construction also can be produced. Wide, thin shapes for building curtain walls are likewise possible. Large extruded pipe for petroleum and

(Continued on page 170)

where HARD RUBBER is right... use it!



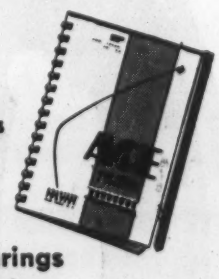
EVERY GLASS OF WATER gives it a whirl

● The little water meter in your cellar puts hard rubber to the most exacting test a material can get. The disc piston, for example: It spends 10 — even 20 — years under water, and oscillates through a dozen cycles for every glass of water. Machined as precise as 0.0005", it must neither warp, swell, nor wear, or the meter's accuracy would be lost.

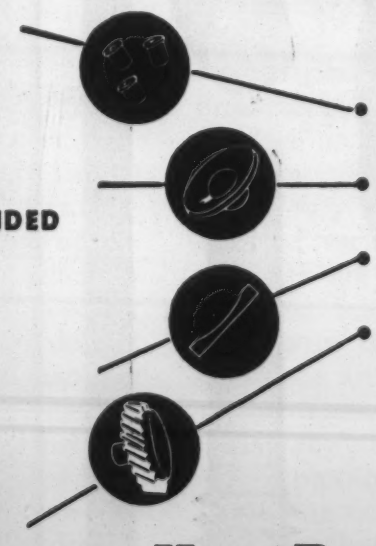
Some discs are blanked from Ace Hard Rubber sheet; others start as moldings with metal cores. Moisture absorption is as low as 0.04%, tensile strength as high as 10,000 psi. Special high-temperature compounds safely handle hot water.

There are Ace Hard Rubber compounds that are ideal for many of your mechanical and electrical parts too. Always consult your Ace Handbook when selecting materials — rubber or plastics — for today's production and tomorrow's plans.

80-page Ace Handbook Free to Design Engineers



HINTS FOR PRODUCTION-MINDED ENGINEERS


Meter bearings cut from tubes
Disc molded over metal core
Bearing plate punched from sheet
Meter turbine wheel, molded and machined

American Hard Rubber Company

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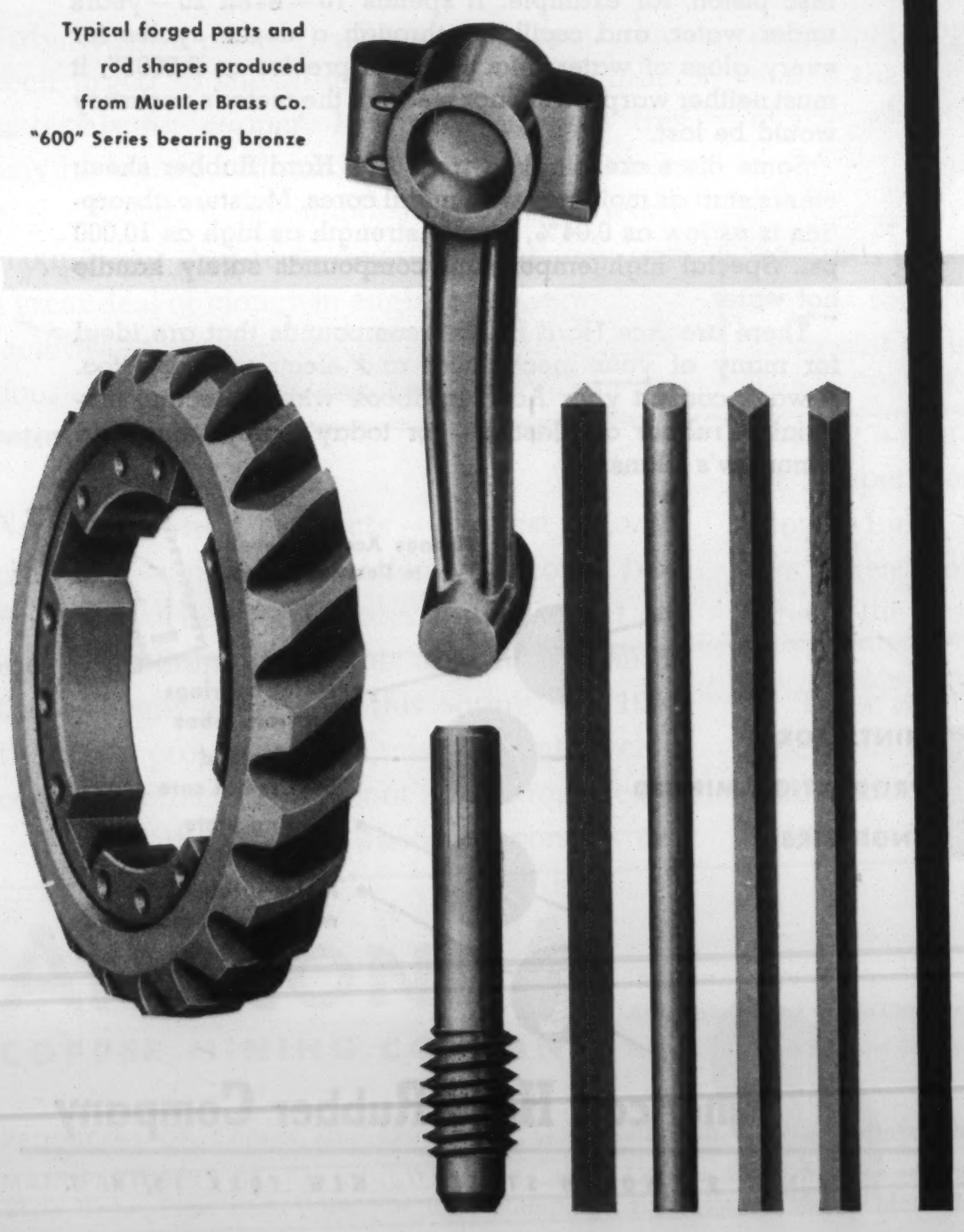
Typical forged parts and rod shapes produced from Mueller Brass Co. "600" Series bearing bronze



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73

EXPERTS VOICE OPINIONS IN AGREEMENT AND REBUTTAL ON—

"A Critical Look at Salt Spray Tests"

Comments on Mr. LaQue's article (in last month's issue) differ widely, but most users and specifiers agree that there is room for improvement in the tests and their application.

● Many corrosion experts are in agreement that salt spray tests are far from satisfactory as they are specified and interpreted today. Comments from these men developed as a result of Mr. Frank LaQue's article, "A Critical Look at Salt Spray Tests", (MATERIALS & METHODS, Feb. 1952, p. 77). A study of the comments received could be summarized in this way: Some experts like the tests; some experts detest them; most agree there is room for improvement in the tests and their applications.

On the positive side, many feel that the salt spray test is a simple, sure way to locate gross discontinuities or pores in plated or paint-type finishes. Others feel that the negative aspects of the tests have been overdone to the extent that such tests might be entirely discarded. Still others feel that with certain materials, aluminum being an example, there is sufficient correlation between salt spray results and exposure tests to make salt sprays useful when handled by qualified men.

Some who do not wholly damn salt spray tests feel that most of the fault lies in the method being improperly specified in seeking results which cannot be found. The improper use could be reduced, if not eliminated, by applying sound human judgment to corrosion problems through trained corrosion engineers.

Taking the extreme view, one correspondent states: "Salt sprays are being used dangerously and to the disadvantage of industry". Another man, thoroughly qualified to realize the method's shortcomings, feels: "There is no place for the test in many specifications", and tells why he believes that to be true.

Most comments on Mr. LaQue's article agree that there is no short cut to experience. In other words, there is no accelerated test which will duplicate the results of actual service conditions. In praising the article, in general, many voice the feeling that by bringing dissatisfaction into the open some progress can be made. Progress should be in the direction of development of new tests which will more factually duplicate service failures and be capable of penalizing faulty manufacturing procedures.

Complete texts of comments of nearly a dozen corrosion experts follow.

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Negative Tone Overdone

Hugh P. Godard, Aluminium Laboratories, Ltd.

I am in agreement with Mr. LaQue in that the salt spray test is often misused and misinterpreted, and appreciate that his article was written to enlighten both the specification writer and the user. In this he has done a good job and pointed out many of the common misunderstandings of this test. However, I feel that the negative tone of the article has been overdone to the point where the reader is apt to completely discard the test as valueless, while as Mr. LaQue admits, this is not the case.

It is far easier to criticize a plan, a viewpoint, or a test than it is to vindicate it, as any politician knows well. All so-called "standard" corrosion tests have been individually criticized as not giving service results, to the point where almost all of them can be rejected on the basis of the evidence submitted. Yet if one rejects each test in turn, in deference to the critics, there are left no methods of evaluation. It would seem preferable, to the writer, at least, to retain the best tests available and to attempt to use them intelligently.

One of the main objections to the salt spray test is that it does not reproduce natural conditions, and hence will not predict service performance even in marine atmospheres. But *any* "standard" test will fail to reproduce natural conditions since they are themselves subject to no control and vary from place to place, and from day to day, and year to year in any one place. Mr. LaQue's experience with marine atmospheric testing confirms this point. When corrosion rates obtained on metals exposed in different atmospheres are compared, the results vary widely, even the relative order of various alloys changes. Yet this does not mean that atmospheric corrosion tests are of no value. It does mean that results obtained in one place are not applicable for all places. Thus, it is inconceivable to expect any standard corrosion test to enable prediction of service life.

Dealing now with the several possible applications of the test suggested by Mr. LaQue:

1. *To Measure the Protective Value*

of a Metallic Coating

Let us assume that this means the evaluation of a new form of metal coating, say aluminum sprayed on steel. The test can be used for this purpose only if it is known in advance that the corrosion behavior of the coating and its galvanic relations with the base metal are similar in the salt spray chamber to those in the environment in which the object is to be used.

Some correlation with behavior in marine environments would be expected, but as Mr. LaQue points out, correlation may be poor in different environments.

2. *To Measure the Protective Value of a Nonmetallic coating*

I agree with Mr. LaQue that the test will apply only to the coating at the time of application and that it will not evaluate resistance to deterioration by sunlight, polluted atmospheres or driving rain. Other tests can be used for this purpose.

On the other hand, the salt spray test gives a measure of the permeability of a nonmetallic film and is a good screening test for eliminating inferior quality products. Also, it is my experience that simple tests are needed to weed out poor quality paints, and that the manufacturer's claims are an insufficient guide to quality.

3. *To Disclose Discontinuities in a Protective Coating*

I am in agreement with Mr. LaQue's discussion of this point.

4. *To Measure Thickness of a Protective Coating*

The test can be used as a measure of the efficacy of application of a given coating. This will sometimes be a measure of thickness, other times of efficiency of pre-cleaning. It serves as a convenient tool for detecting overly thin deposits of electroplate, galvanizing and paint coatings. As Mr. LaQue points out, shape will affect the behavior of the surface and evaluation should be based on the performance of flat surfaces exposed at a given angle. The under sides should be neglected.

5. *To Compare the Corrosion Resistance of Different Alloys*

I am in wholehearted agreement with Mr. LaQue that the test should not be used for this purpose unless one is interested in behavior in 3% or 20% sodium chloride spray and in this only. As pointed out, the test may be used in some alloy families as, for example, aluminum.

6. *To Observe the Galvanic Effects in Dissimilar Metal Combinations*

I believe that in general the test will predict the same galvanic relationship and severity that exist on board ship—the most severe type of marine atmosphere. Ashore, the galvanic corrosivity of a marine atmosphere drops sharply with distance from the beach, and although the same relationships exist, the severity is very much less. For nonmarine atmospheres, the results would have little value.

7. *To Detect the Presence of Free Iron on Some Other Metal Surface*

This heading hardly justifies discussion with the others. Electrographic techniques are far more rapid and accurate than the salt spray test for this purpose.

I don't think that our estimation of the test is so very different, but I am perhaps less pessimistic than Mr. LaQue. There is not so much the matter with the salt spray test—it is the interpretation that is faulty. I believe that it can be used as a screening test to detect poor quality electroplate, other metal coatings such as galvanizing, cadmium, etc., and paint. However, once the quality is better than a certain grade, the test is not suitable for differentiation, say between medium and good grade products. It is my experience that any test that will reveal poor quality tends to cause the producer to raise his sights and this is a desirable objective.

● ● ●

Data as One Piece of Evidence

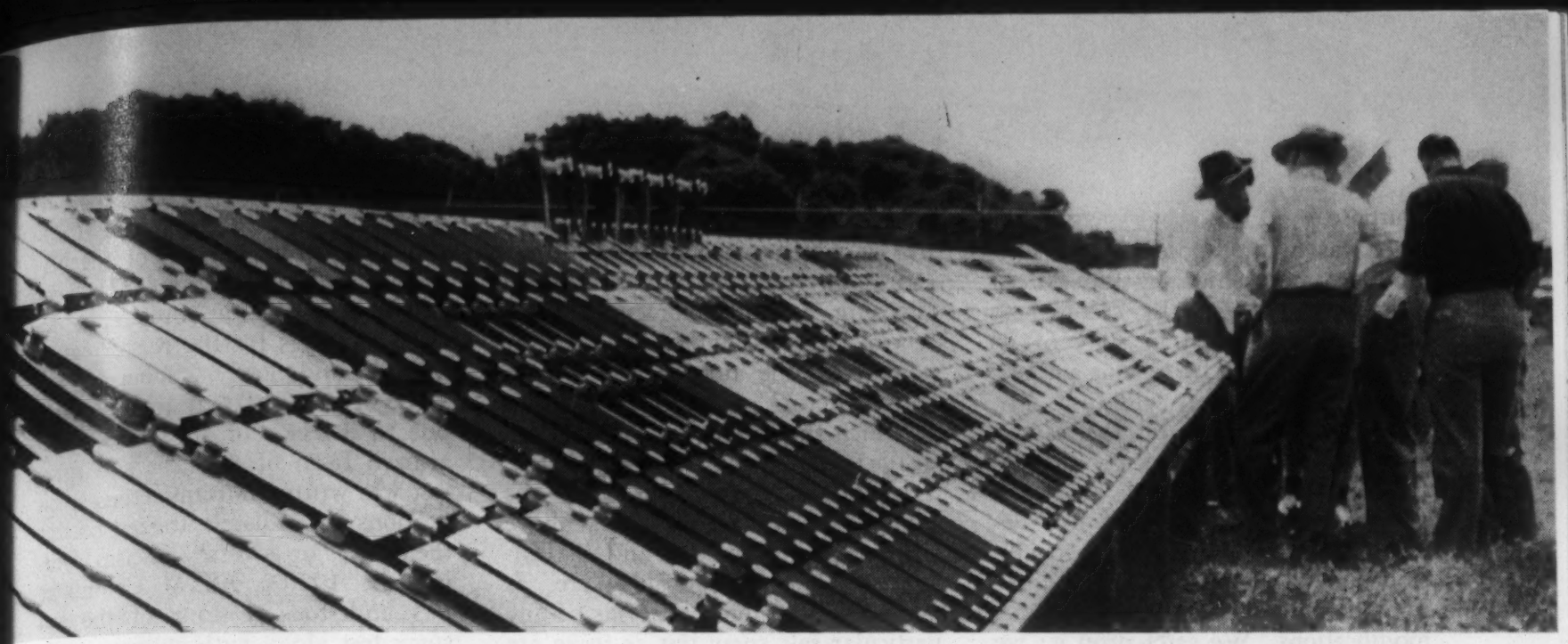
Allen L. Alexander, Head, Protective Coatings Branch, Chemistry Div., Naval Research Laboratory

The paper by Mr. LaQue in which he describes at some length the many shortcomings and dubious merits of the salt spray test is timely indeed in view of the tendency of some individuals to include it as a major requirement in procurement specifications. We were particularly impressed by his classifications of the users of this technique, the first of which is acutely aware of its limitations and is not inclined to place too great significance on the data obtained therefrom, and the second group which appears to conceive of the test as simply a routine experiment, the results from which provide a ready answer to an otherwise perplexing decision. In addition, Mr. LaQue's distinction between the uselessness of the salt spray test as an instrument of research and its possible worth for inspecting different lots of the same product is well taken.

To a somewhat unfortunate degree some consumers of materials and products designed to withstand the deteriorating influence of conditions existing in nature have inclined to rely on results obtained from salt spray tests as an index to the protective qualities of the products offered by a variety of vendors. Such a tendency may be the result of limited resources for conducting exhaustive tests rather than any conviction that this test provides a complete answer. On the other hand, producers of materials for service in this general field have perhaps learned to appreciate more thoroughly the shortcomings and deficiencies of the salt spray test and are cautious to use any data derived therefrom only as one piece of evidence among numerous data in evaluating their product. We can think of no particular instance in which the acceptability of any product can be ascertained by the simple expedient of exposing it to salt spray. There are instances, however, where such data may indicate subsequent tests to elucidate further the protective qualities of the material in question.

As an example of the complete inadequacy of the salt spray test as a means of specific specification requirement, it was brought to our attention some time ago that a number of metal clasps derived from the same production batch were evaluated for acceptability in two laboratories, one located in Chicago and the other in Brooklyn. The sample tested at Brooklyn, based on the salt spray requirement of the specification, passed with no difficulty, whereas in the Chicago test, the batch was rejected due to severe rusting of the metal beneath the supposedly protecting lacquer. On close inspection it was revealed that the tests were run at somewhat divergent temperatures which hitherto the operators of the test boxes had deemed insignificant.

Mr. LaQue's reference to the effect of salt concentration in spray testing is of interest. For example, it is somewhat startling to note the increased rate at which zinc will be removed from a plated steel panel in 20% brine spray as opposed to that obtained from 3% brine. Conversely, the 3% brine will disclose permea-



Many experts agree that there is little relationship between results of salt spray tests and findings of outdoor marine exposure racks such as this one at Kure Beach, N. C.

bility of organic films applied to metal much more rapidly than 20% brine. In the latter example, the more dilute salt solution condensed on the surface of the organic film develops considerably greater osmotic pressure through the semi-permeable film which results in more rapid and extreme blistering. Thus, it would appear that for almost each application the conditions of the test must be closely defined and followed.

It is most interesting to note some of the purposes that Mr. LaQue has listed for which the salt spray test might conceivably be used, and perhaps some comment on several of these is in order. In estimating the protective value of metallic coatings, there is little argument with Mr. LaQue's views. Certainly such a complete set of exposure conditions as are available at the Inco Station at Kure Beach, N. C., will provide a variety of data completely overshadowing in significance anything that may be derived from exposure in a single salt spray cabinet. It perhaps would be difficult to find any significant correlation between a salt spray test conducted in an isolated cabinet with the composite result obtained under the variety of conditions existing at such a complete exposure site. Repeated experiments appear to have negated the possibility of establishing a simple salt spray test that will predict significantly a product's performance under actual exposure conditions. In estimating certain properties relating to the protective value of most nonmetallic coatings, somewhat greater reliance may be made on the salt spray test.

While it is agreed generally with Mr. LaQue's contention that the environment in the salt spray test is more destructive to the basic metal than to the coating itself, this is not always entirely the case. Relative permeability of a number of variable organic films may often be established in relative short order by exposure in a so-called standard salt spray cabinet, although the consensus of the organic coatings industry is to attach little significance to results of such testing beyond the detection of discontinuities or excessive permeability in such films. We know of no reputable purveyors of organic coatings who do not attach much greater significance to exposure in naturally occurring atmospheres where the full effects of light, moisture, repeated precipitation and combinations of these effects do not shade completely any results from the salt spray test alone.

From our own experience it has been reported often that minor metallurgical differences in the composition of some metals, such as magnesium, offset completely the widest differences that may be incorporated into protective organic films when evaluated in salt spray cabinets. Such being the case, it would be a simple matter for an inexperienced individual to select the much poorer of two coatings, should he rely on the salt spray test alone whereas, in fact, his selection would be made actually on the basis of an inferior metal substrate.

The suggestion that the salt spray test be used as a measurement of the thickness of a protective coating should not be taken too seriously in view of the several existing and fairly accurate and more rapid methods. Experience with organic films in the salt spray, however, does indicate a definite relationship between film thickness and protective value. This relationship, however, may be more convincingly demonstrated by other exposure methods.

In view of Mr. LaQue's arguments against the salt spray, we can muster no spectacular rebuttals beyond those included in the foregoing paragraphs. We do not propose to eliminate its use as it applies to some of our problems in the evaluation of organic protective coatings, but we do feel that as a result of our experience, and that recorded by others as presented in Mr. LaQue's paper, that we do not place undue significance on results of the salt spray tests, but rather these results are interpreted in the light of data obtained from other methods of evaluation, with the net result that a more sound decision can be made on the relative quality of several likely materials for a specific application. We wish to emphasize again the fallacy of attempting to correlate exposure time before deterioration with probable life in service.

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A Necessary Evil

J. L. McCloud, Manufacturing Research Dept., Ford Motor Co.

I think it is unfortunate to bury Mr. LaQue's answer as to whether salt spray is good for anything, his answer being that this is not "no". A double negative is damning the test procedure with faint praise at the least. However, all of us in industry who are confronted with the problem of a decision as to whether a process or part is satisfactory have to make a decision on this subject, and over the past at least three decades have found that the salt spray test has given us some clue or basis on which a reasonably intelligent answer to the question as to whether the process or parts are usably satisfactory and have used it for such a

purpose.

It was first proposed, I am sure, in the same fashion by the Bureau of Standards, generally credited to H. S. Rawdon, and in spite of its frequent damning by various authors, it is still in extremely wide use. Mr. LaQue's Committee of the American Electroplaters' Society recommended that substantial study be given to a modification of this device. We agreed to such a conclusion but have no intentions of dropping the test method awaiting such modifications. We can't drop it; we have to continue, but certainly agree with Mr. LaQue that there are many faults and think that we can improve the test technique, rather than go off on a chase for an ideal without something to live on in the meantime.

As Mr. LaQue indicates, there have been many misapprehensions or misunderstandings as to the capabilities of the salt spray test, and I think that his remarks are more valuable in this way, *i.e.* to point out the pitfalls that exist and that too rigorous following of some salt spray results may draw erroneous conclusions rather than to throw it out entirely. As he points out, many have attemped to assume some direct correlation with service life. Unfortunately, service life itself is so extremely varied that it would be a virtual impossibility to correlate any test with service life unless some particular type of very special service life is chosen to compare to. In his article this practical impossibility of choosing an all embracing typical service life is indicated. As he points out, the amount of exposure and sheltering, as well as the locale in which the service occurs, all have distinct influence on the service life.

Unfortunately, the salt spray has limitations, as is indicated above with respect to service and in consequence, there probably are as many different interpretations of any particular salt spray test as there are salt spray test cycles in current use. We have observed as many conclusions which we think are unjustified as those which we feel are justified.

To sum up, we would agree with Mr. LaQue that the test is full of pitfalls, but is a necessary evil and the best way to reform the gal is to marry her.

• • •

Alternative Method Suggested

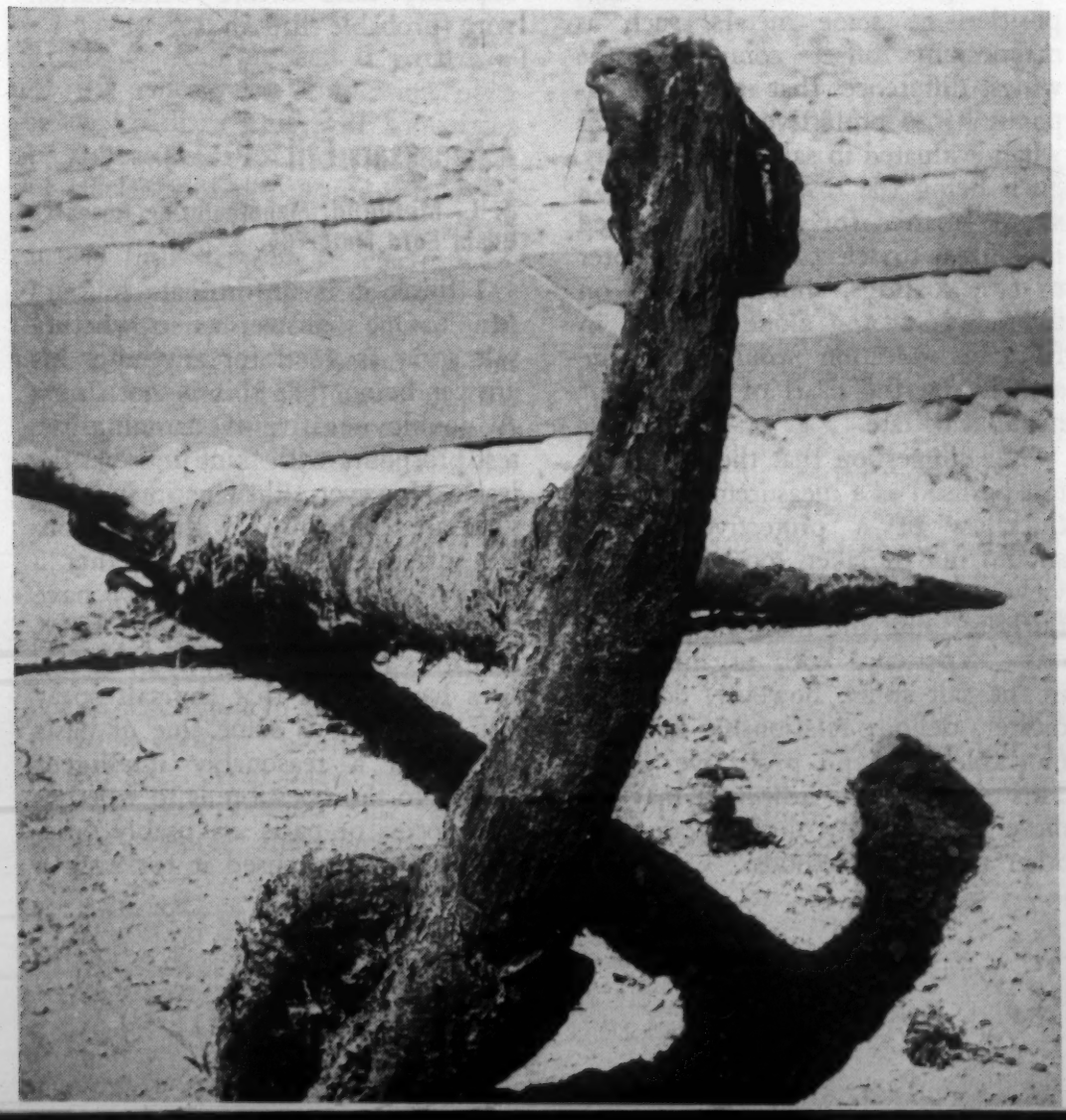
Sam Tour, Sam Tour & Co., Inc.

The salt spray test was devised over 35 years ago. It was proposed as an equivalent of a sea coast or marine atmosphere for the study of protective metallic coatings on iron and steel in 1914 by J. A. Capp in an article published in *ASTM,* Vol. 14, p. 474, entitled "A Rational Test for Metallic Protective Coatings". Circular No. 80 of the National Bureau of Standards, published in 1919, on "Protective Metallic Coatings for the Rust-Proofing of Iron and Steel", expounded the value of the salt spray test. Possibly due to the lack of any other standardized form of test, the salt spray test was written into numerous specifications. Immediately, the test became the subject of adverse criticism. During the 1920's, ASTM Committee B-3 undertook a study of the salt spray test along with studies of numerous other methods of accelerated corrosion testing. Many organizations cooperated in this work of Committee B-3. Large quantities of data indicating the limitations of the test were published.

Until the early 1930's it was the usual practice to operate the salt spray test at ordinary room temperature. About that time, the National Bureau of Standards installed a salt spray chamber in a temperature controlled room that was being maintained for some other purposes at a temperature of 95 F. Naturally, it was found that corrosion proceeded more rapidly at this slightly elevated temperature than at room temperature. This increase in temperature accelerated the rate of testing and this acceleration was claimed to be desirable. About 1936, some of the government agencies changed their requirements in connection with salt spray corrosion testing to conform to this higher temperature. This change resulted in still more exploratory work being done by the various bodies cooperating with ASTM Committee B-3. It was necessary to develop methods of obtaining the desired temperature in the salt spray apparatus without housing the entire apparatus in a large temperature controlled room. A hot water tower to preheat the air supplied to the spray nozzle within an insulated spray box was developed, and has been incorporated in practically all of the current specifications on the method of salt spray testing.

The extensive work of Committee B-3 indicated a need for a method of calibrating or controlling the rate of fog formation and rate of fog settling within a salt spray box. A fog trap for such calibration purposes was developed. After some years, a modified form of fog catching device was adopted and is now standard in salt spray specifications.

The destructive effects of marine exposures are graphically illustrated by this anchor which has lain on a beach for several years.



The first tentative specification covering the method of salt spray (fog) testing as prepared by ASTM Committee B-3 was issued in 1939 under the designation B117-39T. The method was further revised in 1914 and issued as ASTM Specification B117-41T.

In spite of these improvements in the procedure for making the test, it was acknowledged, and continues to be acknowledged by those fully conversant with the test, that the test has many limitations. In 1943, Mr. C. H. Sample presented a paper to the American Society for Testing Materials entitled "Use and Misuse of the Salt Spray Test as Applied to Electrodeposited Metallic Fnishes". His criticisms were severe, although he offered no alternatives to the salt spray test and offered no specific improvement of the test itself. In 1944, Mr. V. M. Darsey presented a paper to the American Society for Testing Materials on "The Salt Spray Test," in which he provided data for further improvement of the test and control of the test so as to be able to obtain more reproducible results. In 1948, Messrs. V. M. Darsey and W. R. Cavanagh presented a paper to the ASTM entitled "Apparatus and Factors in Salt Fog Testing", which was one of the most constructive papers ever presented on this subject. As a result of this work and the cooperation of others interested in the test, the ASTM specification was revised in 1949 and reissued as B117-49T. In its present form, the salt spray test, as carried out in accordance with the ASTM method, is a vast improvement over the salt spray test of 35 years ago.

Whether or not the salt spray test itself can be further improved to overcome some of the criticisms and objections to the test is questionable. It would seem logical that some of the critics of the test would come forward with proposed alternative methods of testing which they think would be more satisfactory than the present salt spray test.

Some 12 years ago, the writer developed an alternative method of testing which he considered as equal to or superior to the salt spray test method. This method of testing has been described the past year in an article entitled "'AC'—A New Corrosion Test" by Thomas E. Lloyd, Editor, *Journal of Metals*, Sept. 1950, pp. 1092 to 1093. A more adequate and detailed discussion of this method may be published elsewhere in the near future.

Mr. LaQue extends the field of criticism of the salt spray test to a criticism of the people who make use of the test. In connection with the class of people whom he designates as "confirmed advocates of the test", he uses such terms as "he has the problem of working out some other kind of test" and "he is unable or unwilling to devise a better test". However, Mr. LaQue does not describe some other kind of test as a better one.

In spite of his severe criticism of the salt spray test, Mr. LaQue admits that it has some application in connection with aluminum alloys and that, as modified by the addition of acetic acid, it has value in testing plating on zinc-base die castings. He states "perhaps other modifications of the test will prove to be useful in adapting it to other specific purposes". If some organization undertook to develop such modifications, it would be of great help to industry. Mr. LaQue's article is constructive only to the extent to which he points out the specific cases in which the salt spray test can be quite useful. His objection to the use of the salt spray test as a tool of research in the development of plating improvements is a bit vague. His bold statement that where the salt spray test has been used as a research method it has delayed progress, is open to some question. His proposal that the salt spray test will continue to handicap research so long as it is substituted for special tests designed to study individually those factors that actually determine the overall quality of product, is meaningless unless he develops and explains these special tests so designed and their applicability.

The writer has no particular brief for the salt spray test as now constituted. The Alternate Condensation Corrosion Test Method is suggested as an alternative test which might be better than the salt spray test. Other workers in the field of corrosion testing should be able to devise and develop improvements in the Alternate Condensation Corrosion Test Method. With cooperative and constructive efforts upon the part of all, it might be possible to develop acceptable test procedures in place of the current salt spray test.

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More Misused Than Used

E. A. Anderson, The New Jersey Zinc Co. (of Pa.)

By bringing Mr. LaQue's provocative article on the salt spray test before the reading public, MATERIALS & METHODS has rendered a signal service to the field of corrosion engineering. The subject has long needed a thorough airing.

My own views regarding the salt spray test coincide very closely with Mr. LaQue's. The evidence is considerable that, while the test may have some useful, legitimate functions, it has been more misused than used. The most flagrant misuse has been in the areas of materials selection for service under corrosive conditions and the prediction of service life. Mr. LaQue has documented the case against these uses quite completely.

If one accepts the salt spray test for what it actually is, a useful acceptance-testing function can be developed providing the endpoint in the testing can be stated clearly and no attempt is made to predict service life from the salt spray data. One may ask, however, whether the advantages to be gained by such use outweigh the great harm done by misuse. Even at the expense of eliminating one of the very few laboratory tools available to the corrosion engineer, I feel that the answer must be no.

It is profitable to give some thought to the reasons for the widespread use of a test which has so many demonstrable defects. The point of gravest concern to the corrosion engineer and his management is the stated need for some kind of evaluation test to replace sound human judgment. One wonders what is wrong with the simple idea of employing and developing corrosion engineers capable of applying sound human judgment to corrosion problems.

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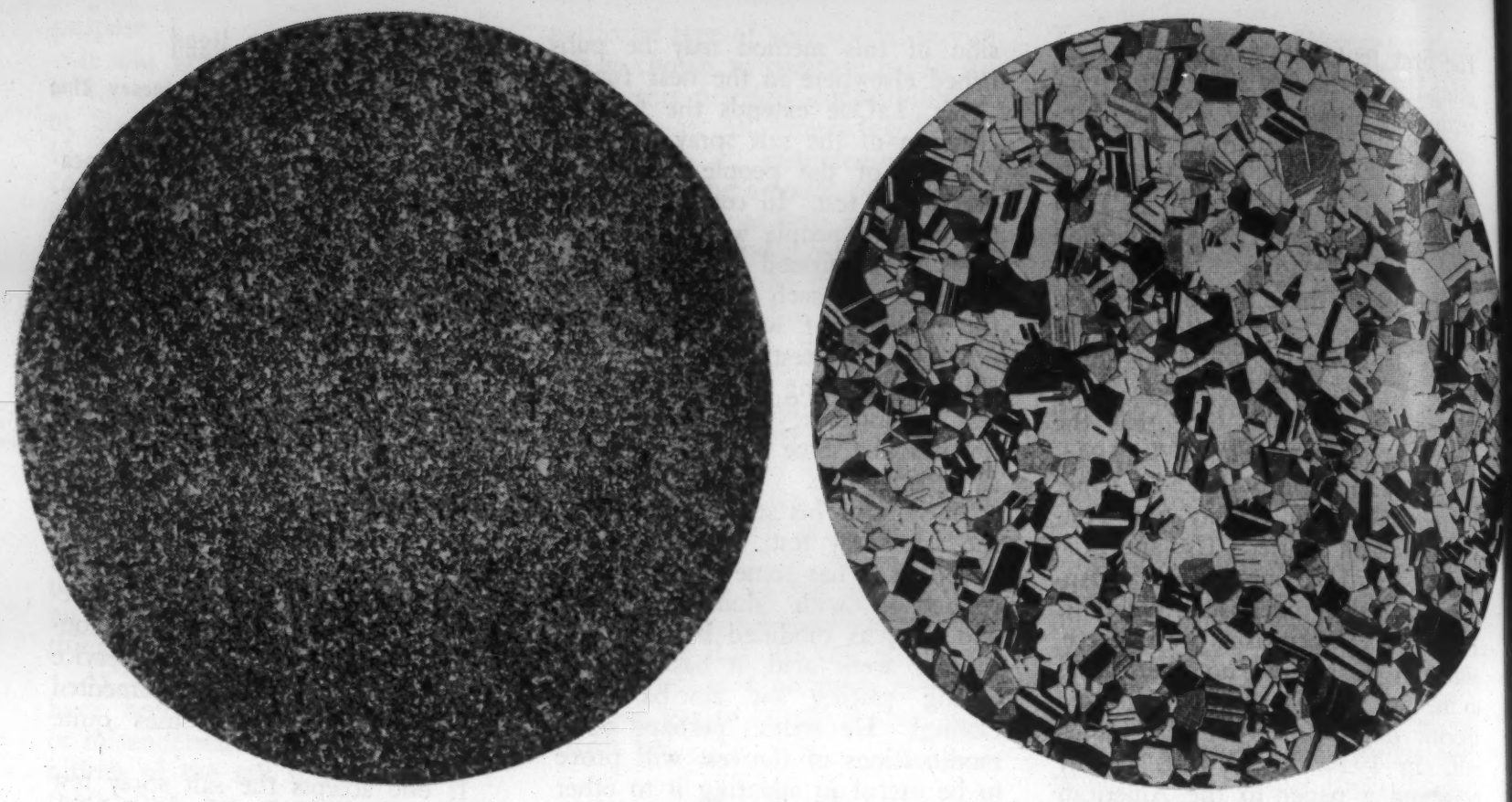
Test Idealized Though Not Ideal

N. E. Promisel, Head, Materials Branch, Dept. of the Navy, Bureau of Aeronautics

I sincerely doubt if there will be many who read Mr. LaQue's article without a sense of enjoyment, on the one hand, and in most cases a feeling of general technical concur-

(Continued on page 156)



Photomicrographs show fine grain size of Formbrite (left) as compared with that of ordinary drawing brass of the same composition. Magnification 75X.

New Drawing Brass Cuts Finishing Costs

by S. G. KELLEY, Jr., Assistant Editor, Materials & Methods

Standard brass alloys, annealed to obtain unusually fine grain size, are giving outstanding results in drawing and cold heading operations.

● MANUFACTURERS OF brass products using press operations, including forming and drawing, or making cold headed parts from wire, can now cut their production costs appreciably through the use of a new type of brass recently announced by The American Brass Co. By requiring less time for finishing and polishing, the new material is proving itself valuable in a number of ways.

Called Formbrite, the metal is not a new alloy, but is the result of a new process of manufacturing that can be applied to most of the existing copper alloys, particularly the brasses. As a brass, Formbrite can be obtained in alloys ranging from gilding metal (95 copper-5% zinc) to yellow brass of 63-37, copper-zinc content. Produced by special methods of rolling or drawing and annealing, it has a grain size of 0.012 mm or under.

Properties

Formbrite, with its superfine grain structure, is said to possess very good polishing and finishing characteristics, high tensile strength, hardness and excellent ductility. The accompanying table shows a typical comparison of some of the physical properties of standard brass and those obtained in Formbrite. The new material is somewhat stiffer than conventional annealed brass, is harder and springier, yet it still is ductile and readily worked by forming or drawing operations with no appreciable danger of metal fracture. In common with most brasses, it is an excellent metal for plating.

These properties give Formbrite several outstanding advantages over ordinary drawing brass. Of these, the most important is the ability to take a good finish. The exceptionally fine grain structure of Formbrite provides metal with a surface so fine that it usually requires only a simple color buff before plating. By comparison with regular drawing brass, there is a marked reduction in the time required to bring up a high finish in buffing and polishing operations on Formbrite. Parts have none of the familiar "orange peel" effect found with metal of coarser grain size.

A second advantage of special interest in these days of metal shortages is the fact that the greater hardness and stiffness of Formbrite sometimes makes it possible to use a thinner gage of metal.

It might well be asked at this point why Formbrite does not completely replace drawing brass. It isn't that easy. It is not practical to produce the exceptionally fine grain in relatively thick metal. Formbrite is available, however, for most drawing and forming purposes.

It has sometimes been found necessary, in changing over from usual brasses to Formbrite, to make certain minor tool modifications or operating adjustments. For instance, in one case where a part of soft drawing brass was fabricated with a pressure of 8 to 10 lb on the hold-down pad, it was necessary to increase the pressure to 25 lb to draw Formbrite of the same alloy without wrinkling. As the changes are generally small ones, such as this, they are not usually considered as limitations to the method.

Applications

Those who are using Formbrite are reporting notable results in the finishing of their products. One manufacturer of lamp fixtures reports that he has cut buffing time by 50% and obtained better finishes as well. Another, who stamps reflectors, states that his costs, outside of plating, have dropped 25%.

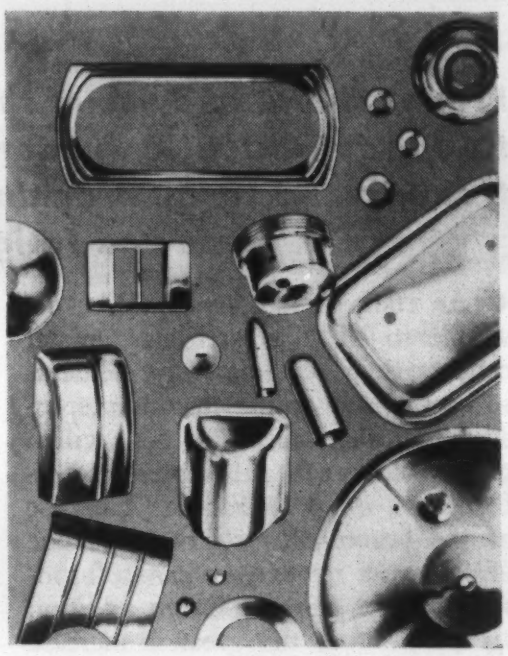
The Asterloid Manufacturing Co., a manufacturer of dresser sets, cosmetic holders, etc., previously used annealed 85 red brass for the production of the handles on mirrors and brush sets. In an effort to reduce the cost of polishing, Formbrite strip of the same alloy was tried. Obtained in rolls 8 in. wide and 0.032 in. thick, the Formbrite strip was sheared to 1⅝-in. blanks and each half of the handle was formed on a 400-lb "Standard" pneumatic drop hammer. The embossing obtained has excellent definition, as seen in the accompanying photograph, while "springback" was negligible and so uniform that the halves matched perfectly on assembly. The savings occurred in the polishing operation, "a cut-down and color" procedure, which was accomplished in about half the time required previously by standard drawing brass. The results were so satisfactory that Formbrite is now the standard metal for these parts.

Several other manufacturers who buff, but do not plate their parts, have indicated a marked improvement in the appearance of the products. Principal economies are obviously in the savings effected in finishing costs. Formbrite, incidentally, costs no more than the usual drawing brass.

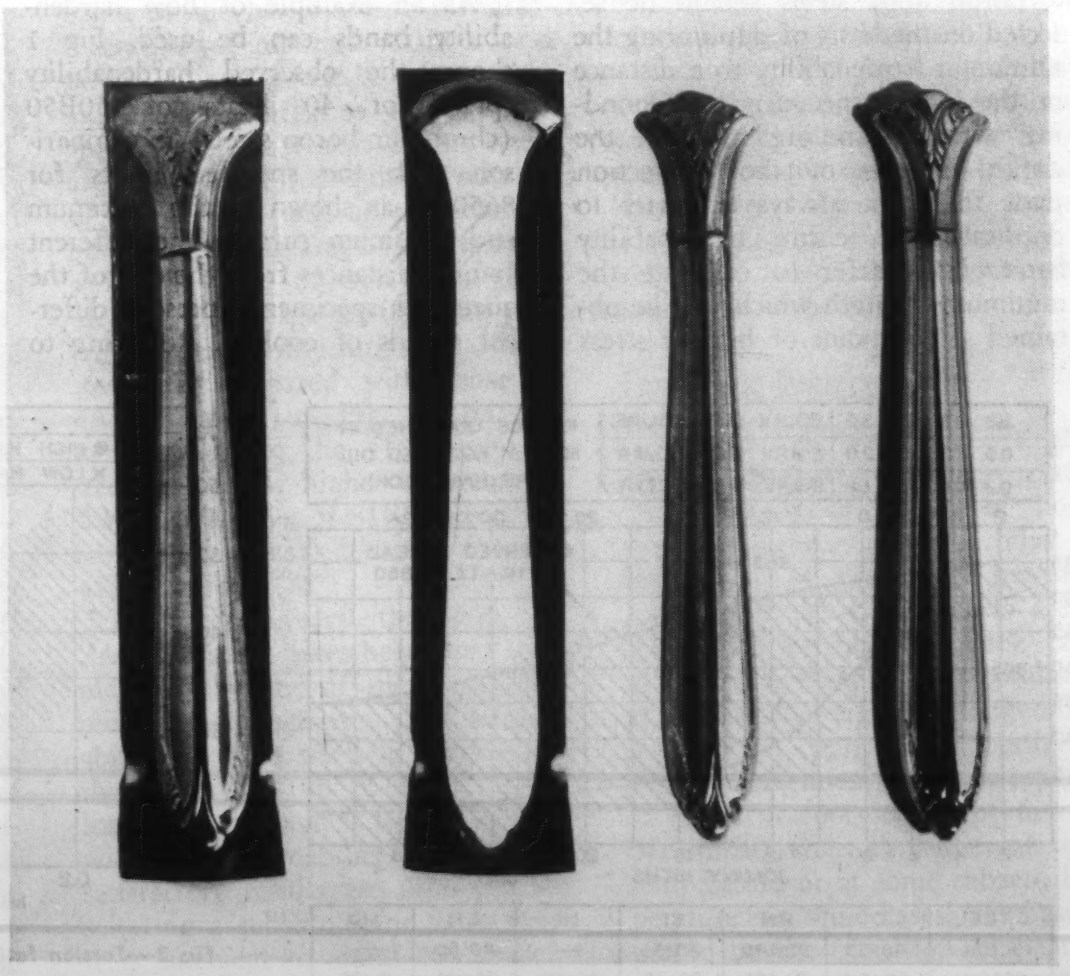
It is claimed that the results obtained by applying the Formbrite method of brass wire alloys used for cold heading are exceptional. The wire can be supplied in the single, standard temper which materially reduces fabricators' inventories. Its superior physical properties have permitted cuts in cost through the use of brasses having a lower copper content. It is being widely accepted by users of cold heading wire to the point that a number of them use, exclusively, wire alloys produced by the Formbrite method.

Properties of Standard Brass and Formbrite

	Annealed Standard 70/30 Brass	Half Hard Standard 70/30 Brass	70/30 Brass by Formbrite Method
Yield Strength—0.5% Extension under Load, Psi	22,000	48,000	39,000
Tensile Strength, Psi	54,000	60,000	63,000
Elongation in 2 In., %	50	32	35



A selection of stamped, drawn and pressed parts typical of those in which Formbrite is being used with unusual success.



Sequence of steps employed by the Astorloid Manufacturing Co. to make a mirror handle by embossing. Note the good detail and high finish obtained.

Hardenability as the Criterion for Selecting Boron Steels

by H. B. KNOWLTON, Supervisor of Materials Engineering, International Harvester Co.

Proper choice and use of the new boron steels depends to a great extent on understanding the effects of heat treating and case-hardening on their hardness, toughness and fatigue properties.

● AS TIME GOES ON, it will be desirable to effect greater and greater conservations of alloying elements so as to produce the maximum possible military material or civilian goods, consistent with successful performance of the product. The use of the boron alloy steels offers one of the most attractive means of conserving alloys as the boron addition agents produce the greatest increase in hardenability in proportion to the per cent of material added.

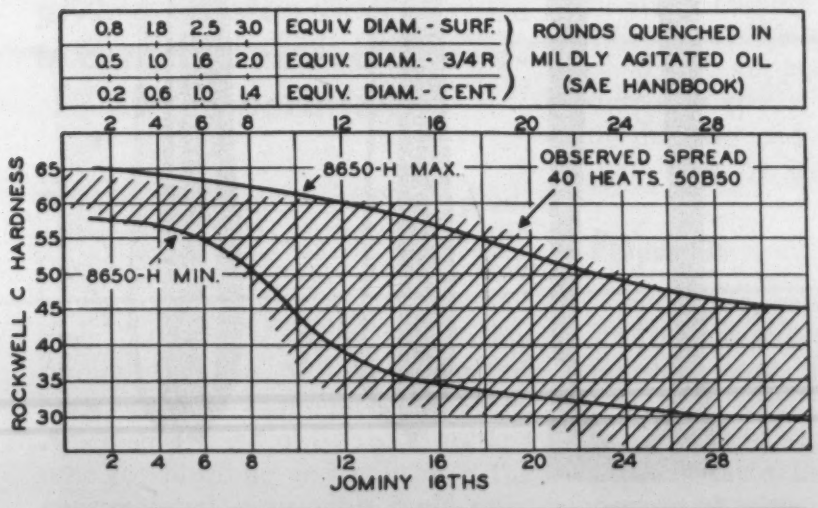
Selection Based on Hardenability

Boron alloy steels should be selected on the basis of duplicating the minimum hardenability to a distance on the Jominy specimen, corresponding with the cooling speed of the critical section of the production part. It is not always necessary to duplicate the entire hardenability band. It is safer to calculate the minimum strength which will be obtained at the point of highest stress on the cross section, on the basis of the minimum hardness which will be obtained at this point after a production quenching and drawing treatment, rather than on the basis of tensile specimens taken from the center, or half radius, positions. Similarly, minimum physical properties representing the bottom of the expected hardenability band for the boron steel are more reliable than the most elaborate of service tests made upon parts manufactured from lots of steel representing the middle or upper portion of the hardenability band.

As an example of how hardenability bands can be used, Fig 1 shows the observed hardenability spread of 40 heats of 50B50 (chromium-boron steels) in comparison with the specified limits for 8650-H, as shown by the maximum and minimum curves. The different Jominy distances from the end of the quenched specimen represent different speeds of cooling. Referring to the SAE Handbook, it may be convenient to correlate these Jominy distances from the quenched end with speeds of cooling, which would be expected on the surface, or different points over the cross section of round bars after quenching in either oil or water. Such figures are shown at the top and bottom of the graph.

It will be noted that all 40 of the heats of 50B50 steel showed as good hardenability as 8650-H, up to about 7/16ths on the Jominy specimen. This would correspond with the surface of an oil quenched bar 2¾ in. in dia, or the ¾ radius position of an oil quenched bar 1¾ in. in dia. The ¾ radius position is a convenient one for comparing hardenabilities of many heat treated automotive parts, as Jominy has shown that in the great majority of cases the highest stress never appears lower than ¾ radius in common automotive parts. In other words, ¾ radius probably represents the maximum depth of a spline, a keyway, or a fillet, which is machined after heat treating.

On the basis of these results, it will be assumed that 50B50 steel would give as satisfactory results as 8650-H for most oil quenched parts up to


0.8 1.8 2.5 3.0 EQUIV. DIAM. - SURF.
0.5 1.0 1.6 2.0 EQUIV. DIAM. - 3/4 R
0.2 0.6 1.0 1.4 EQUIV. DIAM. - CENT.
ROUNDS QUENCHED IN MILDLY AGITATED OIL (SAE HANDBOOK)
ROCKWELL C HARDNESS
8650-H MAX.
8650-H MIN.
OBSERVED SPREAD 40 HEATS 50B50
JOMINY 16THS

STEEL	C	MN	SI	NI	CR	MO
50B50	.48-.53	.75-1.00	.20-.35	—	.40-.60	—
8650-H	.46-.54	.70-1.05	.20-.35	.35-.75	.35-.65	.15-.25

Fig 1—The hardenability of 50B50 is similar to that of 8650-H.

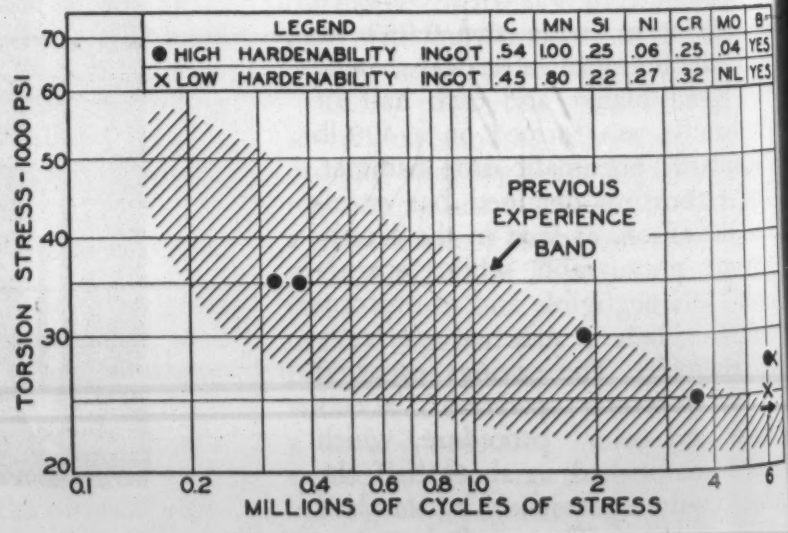

LEGEND C MN SI NI CR MO B
● HIGH HARDENABILITY INGOT .54 1.00 .25 .06 .25 .04 YES
X LOW HARDENABILITY INGOT .45 .80 .22 .27 .32 NIL YES
TORSION STRESS - 1000 PSI
PREVIOUS EXPERIENCE BAND
MILLIONS OF CYCLES OF STRESS

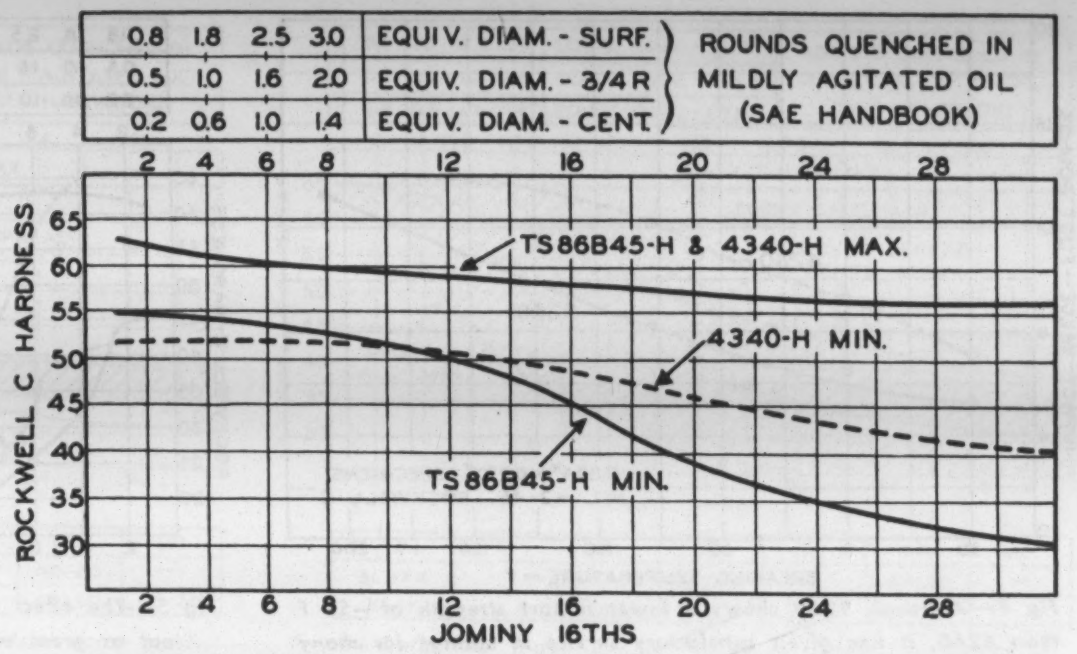
Fig 2—Torsion fatigue tests indicate that the fatigue properties of 50B50 compare quite well with experience based on other steels.

1¾ in. in dia. Similarly, this should give equivalent properties at ¾ radius on water quenched parts up to 3.3 in. in dia. This is based on data given in the SAE Handbook for rounds which are quenched in very slowly circulated oil and water. With rapid circulation, similar results can be obtained with rounds somewhat larger in diameter.

To illustrate the practical application of this principle, Fig 2 shows the result in torsion fatigue tests of tractor axles, which were 2¾ in. in dia in the critical section, and were made from high and low hardenability heats. These were machined from 3⅛-in. dia bars, water quenched and drawn to 321-388 Bhn. It will be noted that there is a wide variation in the number of cycles to failure at any given level of stress. On the other hand, the variation in stress necessary to produce failure in a given number of cycles is very much less, being in this instance about 22,000 to 25,000 psi, representing a stress which can be carried for 6 million cycles. This is probably nearer to the so-called "endurance limit", or the stress which can be withstood for an indefinite number of cycles. None of the axles from either the high or low hardenability ingots of steel showed inferior fatigue properties to 8650.

It is worth noting, however, that there is a tendency for the minimum hardness of the boron steels to fall below the original curve at 10-16 sixteenths on the Jominy. This means that for very large parts there might be some sacrifice in hardness and strength with the new steels, but for the majority of automotive parts the hardenability should be sufficient. The 50B50 steel was selected for these illustrations due to the availability of data within the writer's company of both hardenability and simulated service performance of axles and shafts made from these steels.

The same principles can be applied to the use of hardenability bands for the selection of 80B00, 81B00 steels for a wide variety of heat treated parts. Eventually the steel producers will undoubtedly establish specified limits of hardenability for these steels in the form of new H-bands. In the meantime, however, the user of the steel must assure himself that each lot of steel he purchases has sufficient hardenability to guarantee the required minimum physical properties of all parts,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0.5 1.0 1.6 2.0 EQUIV. DIAM. - 3/4 R
0.2 0.6 1.0 1.4 EQUIV. DIAM. - CENT
ROUNDS QUENCHED IN MILDLY AGITATED OIL (SAE HANDBOOK)
ROCKWELL C HARDNESS
TS86B45-H & 4340-H MAX.
4340-H MIN.
TS86B45-H MIN.
JOMINY 16THS

STEEL	C	MN	SI	NI	CR	MO
TS86B45-H	.42-.50	.70-1.05	.20-.35	.35-.75	.50-.80	.08-.15
4340-H	.37-.45	.60-.95	.20-.35	1.50-2.00	.65-.95	.20-.30

Fig 3—Comparison of the proposed hardenability limits for 86B45 with those of 4340-H.

which are to be made from this steel. In general, it is possible to obtain curves from the steel producers showing the actual hardenability of each heat of steel furnished to the consumer. At present, it is the responsibility of the consumer to apply only those heats which have adequate hardenability for each type of production parts.

In the main, it has been found that the hardenability of the 50B00 series and the 80B00 series is equivalent to that of the 8600 series steels at similar levels of carbon content. Some of the heavy spring manufacturers have reported 50B60 and 80B60 as equivalent to 8660, 9260 and similar steels, so far as their springs are concerned. Boron steels are being used for quite a number of heat treated parts on a production basis. Caterpillar Tractor has reported satisfactory use of 86B45 in place of 4340 for large shafts. The proposed hardenability limits for 86B45 steel are compared with those of 4340-H steel in Fig 3. As the hardenability of the 4100 series of steels is slightly higher than that of the 8600, a series of 81B00 steels has been set up as alternates for the 41XX.

For some years the 400, or "Amola" steels have been used commercially by one of the large automotive manufacturers. The hardenability of these steels is slightly less than that of 4100 or 8600, but as long as the design is kept consistent with the hardenability of the steel, satisfactory results are produced. In selecting a substitute for these steels it is sufficient to equal the hardenability of the steels now being used. On this basis, the 8000 series steels without the addition of boron appears to be adequate.

It has been claimed, however, that connecting rod bolts with Place type heads cannot be formed satisfactorily from the 8000 series steels. Consequently, it has been suggested that they be made from a modified 40B35, having a molybdenum content of 0.08-0.15. These steels seem to be satisfactory for small bolts. Where higher hardenability is necessary, it is suggested that standard 4037, or a proposed 40C37 similar to standard 4037 with the addition of chromium, be used.

Caterpillar Tractor has been using a boron treated carbon steel, now officially classified as 14B35, for oil quenched bolts up to 7/16 in. in dia, and for water quenched about 1 to 1¼ in. in dia. Satisfactory results over a period of several years have been reported.

Toughness Requirements

Some writers have placed a great deal of emphasis upon the relative toughness or brittleness of boron steels in comparison with other alloy steels. In general, it has been found that the boron steels are as tough, or tougher, than the other alloy steels, except under conditions of slack quenching or prolonged high temperature tempering treatments. Relative toughness is usually reported in terms of foot-pounds of notched bar impact strength, either at room temperature or at some subzero temperature. In some cases, emphasis is placed on the transition temperature at which impact specimens contain-

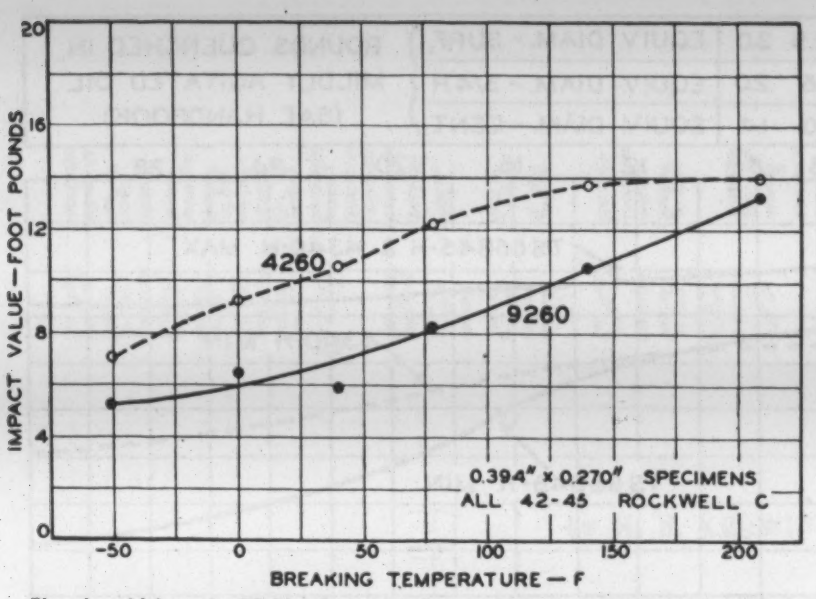
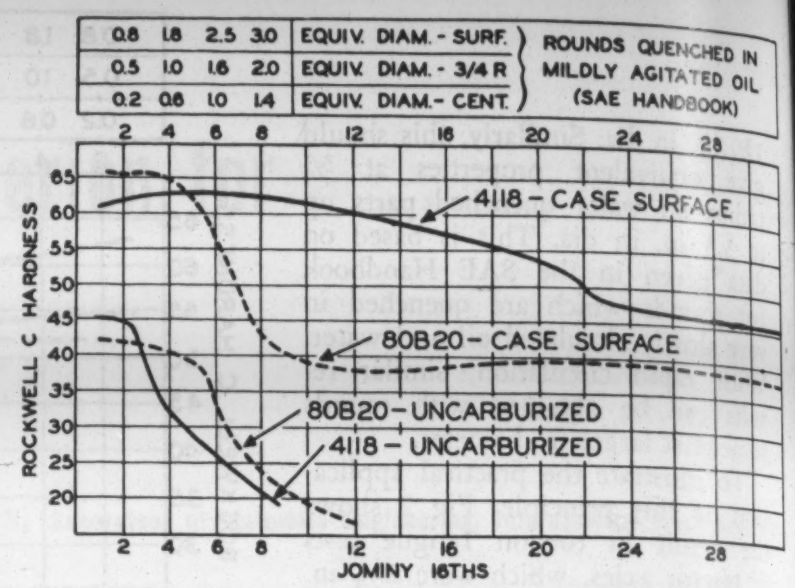


Fig 4—Although 9260 shows a lower impact strength at −50 F than 4260, it has given satisfactory service in springs for many years at even lower temperatures.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0.5 1.0 1.6 2.0 EQUIV. DIAM. - 3/4 R
0.2 0.6 1.0 1.4 EQUIV. DIAM. - CENT.
ROUNDS QUENCHED IN MILDLY AGITATED OIL (SAE HANDBOOK)
ROCKWELL C HARDNESS
JOMINY 16THS
4118 - CASE SURFACE
80B20 - CASE SURFACE
80B20 - UNCARBURIZED
4118 - UNCARBURIZED

Fig 5—The effect of boron upon the hardenability of a steel is not as great with high carbon as with low carbon steel.

ing sharp V notches exhibit a change from tough to brittle performance. This is often misinterpreted as predicting that production parts with good commercial fillets will also behave in a brittle manner at such temperatures. Actually, if the impact specimens are made with round notches corresponding to production designs, the apparent transition temperature between tough and brittle performance can be lowered 100 F or more.

Fig 4 shows the impact transition temperature curves for 9260 and 4260 spring steels. It will be noted that the 9260 steel shows an impact strength of only 5 ft-lb at −50 F, while the 4260 chromium-molybdenum steel is considerably better. Tests run to date on boron steels, such as 50B60 and 80B60, would indicate that the cold impact strength will probably be 10 ft-lb or more. The important point is that 9260 was a standard steel for springs for a period of a good many years, and gave satisfactory performance in Canada and Alaska at temperatures even lower than −50 F. The criterion for selection of an alternate steel, therefore, is that it should have a cold impact strength of not less than 5 ft-lb at −50 F. If this is ample to prevent brittle failure of springs at the lowest operating temperatures, there would be no additional merit for steels having impact strength of 20-30 ft-lb.

It is necessary that every part have sufficient toughness to prevent brittle types of failure. However, the toughness requirement in terms of impact strength at the operating temperature may be considerably lower than commonly supposed. Very few automotive metallurgists have found it necessary or desirable to impose impact specifications for the acceptance of automotive steels. This is probably due to the fact that most heat treated automotive steels usually have ample impact strength. Those who have done so have set up requirements which are within reason.

So far as reduction of so-called impact strength after normalizing, or after high drawing treatments, is concerned, the writer would again recommend that the minimum toughness required for successful performance should first be determined. The writer would be inclined to doubt whether there would be any difference in performance of any automotive parts made from steels having 40-ft-lb or 80-ft-lb impact strength. There is no doubt, however, that lowering the impact strength from 10 ft-lb to 2 ft-lb might be very disastrous for many parts.

Before adopting an alternate steel, it is well to determine whether this steel will respond satisfactorily to commercial manufacturing processes. While there has not been much information published on this subject with regard to the boron steels, it seems to be generally believed that the forgability, machinability and weldability of the heat treating grades of boron steels will be similar to that of the other alloy steels.

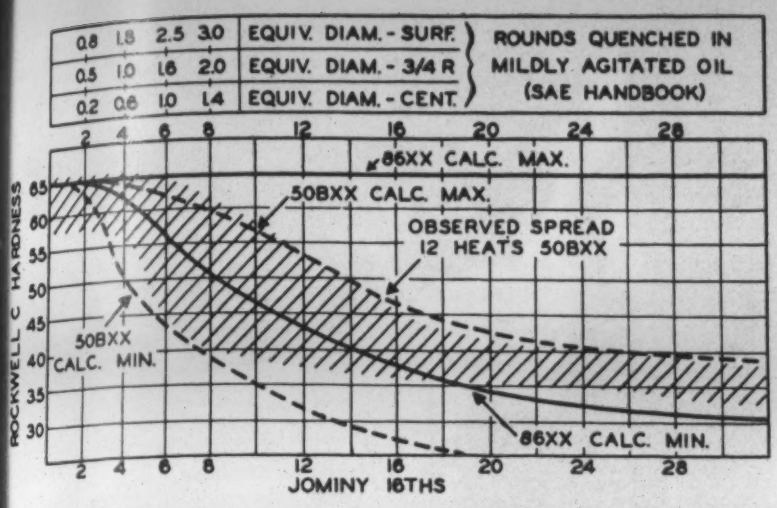
Case Hardened Parts

In spite of the fact that the boron steels were strongly recommended on account of the great effect of boron on the hardenability of low carbon steel, there seems to be more differences of opinion with regard to the merits of boron steels for case hardening than for any other application. Nevertheless, some case hardened gears are being made in production from the boron steels.

The hardenability of the case portion of boron steels cannot be predicted from the hardenability of the core. Wray has shown that the effect of boron on the hardenability of steel decreases with increase of carbon content. He states that there is little or no effect of the boron upon the hardenability of steels containing 0.90% carbon. Jominy, Thomson and some others who have made studies in quenched specimens do not quite agree with this statement. The fact remains, however, that the effect of boron upon the hardenability of the steel is not as great with high carbon as with low carbon steel. Consequently, if an alternate case hardening steel is set up on the basis of duplicating the hardenability of the core, there is danger that the hardenability of the case, particularly any portion containing over 0.90% carbon, will be less than that of the original steel. This is illustrated in Fig 5, which shows the results of hardenability tests on the core and on the surface of the carburized gears of 4118 and 80B20 steels. It will be noted that the 80B20 shows a higher hardenability in the core.

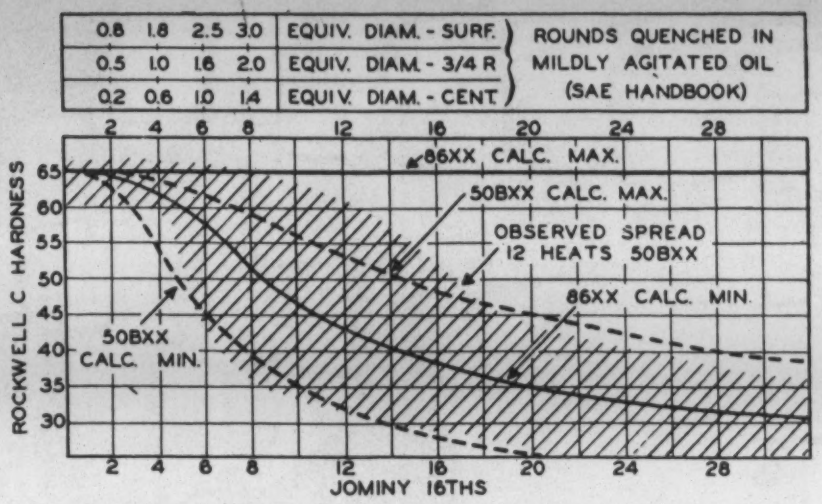
At 6/16ths on the Jominy specimen, 4118 shows a Rockwell hardness of 25 as compared with 32 for the 80B20. This corresponds with a quenching speed similar to that of the center of a 1-in. round oil quenched specimen. In this case, the reverse is true. The surface hardness of the carburized Jominy bars at 6/16ths from the quenched end is 63 Rockwell C on the 4118, and barely 56 Rockwell C on the 80B20. This corresponds with the surface hardness of a 2.5-in. dia oil quenched specimen. At 8/16ths on the carburized Jominy, the hardness of the 4118 is still 62 Rockwell, while that of the 80B20 has dropped to 43 Rockwell. This corresponds with the surface of a 3-in. round oil quenched specimen.

The effect of boron on the case


0.8 1.8 2.5 3.0 EQUIV. DIAM. - SURF.
0.5 1.0 1.6 2.0 EQUIV. DIAM. - 3/4 R
0.2 0.6 1.0 1.4 EQUIV. DIAM. - CENT.
ROUNDS QUENCHED IN MILDLY AGITATED OIL (SAE HANDBOOK)
86XX CALC. MAX.
50BXX CALC. MAX.
OBSERVED SPREAD 12 HEATS 50BXX
50BXX CALC. MIN.
86XX CALC. MIN.
ROCKWELL C HARDNESS
JOMINY 16THS

STEEL	C	MN	SI	NI	CR	MO
50BXX		.75-1.00	.20-.35	—	.40-.60	—
86XX		.70-.90	.20-.35	.40-.70	.40-.60	.15-.25

Fig 6—The minimum hardenability of the carburized boron steels, 50B00, at the surface is somewhat lower than that of the 8600 steels at Jominy distances beyond 4/16ths.


0.8 1.8 2.5 3.0 EQUIV. DIAM. - SURF.
0.5 1.0 1.6 2.0 EQUIV. DIAM. - 3/4 R
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ROUNDS QUENCHED IN MILDLY AGITATED OIL (SAE HANDBOOK)
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ROCKWELL C HARDNESS
JOMINY 16THS

STEEL	C	MN	SI	NI	CR	MO
50BXX		.75-1.00	.20-.35	—	.40-.60	—
86XX		.70-.90	.20-.35	.40-.70	.40-.60	.15-.25

Fig 7—Carburized hardenabilities 0.015 in. below the surface of 50B00 steels based on experience.

and core with no other change in chemistry was investigated. Boron was added in the form of Grainal 79 to a portion of a heat of 4118 steel. It should be noted that there was no difference between the hardenability of the surface with, and without, boron. The hardenability of both steels at 0.015 in. below the surface was inclined to be higher than the hardenability of the surface. The boron steel showed only a slight improvement in hardenability in terms of Rockwell hardness at any given Jominy distance between 8 and 22/16ths from the quenched end. If the hardenability is expressed in terms of Jominy distance to 60 Rockwell C, it should be noted that the boron steel showed 60 Rockwell at 18/16ths compared with the same hardness at 12/16ths on the steel without the boron.

Fig 6 and 7 show the experience to date so far as carburized hardenability of 50B00 steels are concerned. It will be noted that the minimum hardenability of the carburized boron steels is somewhat lower than that of 8600 steels, at Jominy distances beyond 4/16ths. This corresponds with the surface hardness of a 1.8-in. dia bar, quenched in slowly circulating oil. It would be equivalent to the surface hardness of a larger bar with better quenching. It would be expected, therefore, that even with a minimum hardenability heat of 50B20, it would be possible to obtain a surface hardness after carburizing and hardening at the roots of the teeth of 57 Rockwell C on small and medium sized gears. Pinions over 2-in. root dia might require special quenching.

Considerable trouble has been reported with distortion of case hardened gears made from boron steels. This is usually attributed to the fact that boron produces a greater effect upon the hardenability of the core than the case. The greatest difficulty seems to have been experienced with excessive and nonuniform shrinkage of splined holes. Reduction of the carbon content of the steel is usually beneficial in reducing the troubles with distortion. Some plants, however, have reported that when the carbon content is very low, the steel is inclined to be too soft for best machinability in gear cutting. This can be compensated for by increased rake angles for simple tools, but it is not practicable to change the grinding of gear shaping cutters.

In spite of some of the difficulties enumerated, a number of the gear manufacturers have been successful in making satisfactory gears from the boron steels. The results of dynamometer tests of gears made in two different plants show that in every case the performance of the boron steel is at least as good as that of the previous case hardened steel.

It is usually considered that 4820 would be one of the most difficult steels to replace for case hardened parts. Mack Truck has been successful in replacing this steel with 43BV14 for certain gears and pinions. Timken Detroit Axle has reported very good results in replacing 4620 with 94B17 for final drive truck pinion and gears.

The study of the substitution of different types of steels for case hardened gears and pinions is complicated by the fact that variations in carburizing and quenching are very important factors. It is generally agreed that the maxmium hardenability will be obtained only when the carbon content is approximately at the eutectoid ratio, which for most steels is about 0.90% carbon. Some contend, however, that excess carbides in a finely divided or spheroidal form may improve the wearing properties of the gear, even though they reduce the hardenability slightly. It has been reported that decreasing the quenching temperature after carburizing from 1650 to 1550 may produce better hardenability.

Not a great deal of information has been submitted as yet with regard to the effect of carbonitriding on boron alloy steels. Simon has made some investigations of this phase of the subject, and has reported a decrease in hardenability when ammonia is used in the process. In other words, straight carburizing gave better hardenability than carbonitriding.

The use of boron steels is only one approach to the problem of conservation of alloying elements. The new 8000 and 8100 series steels without boron have advantages for some applications. Furthermore, plain carbon steels, such as 1045 and 1050, with the help of induction hardening, torch hardening, and special heat treatments involving drastic quenching, have been found very valuable for certain applications. In some cases, performance tests have shown the specially treated carbon steels to be equal, or superior, to the older alloy steels. The control of residual stress set up by heat treatment is one of the most important factors influencing the service performance of finished parts. Austempering, martempering, and the special treatments just mentioned, all have an important effect upon the residual stresses left in the steel. The whole study of improved techniques for heat treatment of carbon steels probably offer the greatest possibilities for conservation.

This article was adapted from a paper delivered at the Society of Automotive Engineers annual meeting, Detroit, Jan. 14-18, 1952.

The high hardness and dimensional stability of ceramics makes them ideal for wear plates used in gaging operations such as shown here. (All photos courtesy American Lava Corp.)

Technical Ceramics for Wear Resistant and Dimensionally Stable Parts

by S. G. KELLEY, Jr., Assistant Editor, Materials & Methods

The exceptionally hard and dense vitreous type ceramics are being used in such widely diverse applications as wire, twine and thread guides, drawing and extrusion dies, reference plates, and spacers in electronic equipment.

● IN APPLICATIONS WHERE wear resistance and dimensional accuracy are the prime requisites, technical ceramics should be given careful consideration.

The majority of ceramic parts utilized in wear resistant or dimensionally stable applications are made from vitreous ceramics. The two main reasons for this are that: (1) vitreous ceramics are composed of particles of especially fine size and hence are denser than other types of ceramics; and (2) their exceptional hardness surpasses even that of some of the sintered carbides. Most satisfactory are those composed chiefly of aluminum oxide bonded with silica, clay, or combinations of these materials. However, in the production of aluminum oxide ceramics, high firing temperatures are required, and, for economy in manufacture, it is sometimes advisable to use other vitrified ceramics which may not be quite as hard or strong. In such cases zircon porcelain, steatite porcelain, or similar vitrified materials may meet the requirements equally well.

Properties and Fabrication

A fairly broad range of properties is possible in ceramics by introducing changes in: (1) the ratios

of the quantities of the constituents present, (2) the particle sizes of the ingredients, and (3) the firing temperatures (to a lesser extent and depending upon the first two variables). Where it is found that several types of the same basic ceramic are available, the differences can usually be attributed to such changes.

Speaking generally, vitreous ceramic materials can be called ideal elastic bodies because they break without any trace of plastic deformation. The elastic limit and the ultimate breaking point are practically identical. They will neither permanently stretch nor flow under load or strain, but return to their original shape after release. Compared with metals, ceramic materials are brittle. Their impact resistance is low and most mechanical failures can be attributed to impact blows. Compressive strengths are in the same order of magnitude as those of metals while tensile and flexural strengths are much lower.

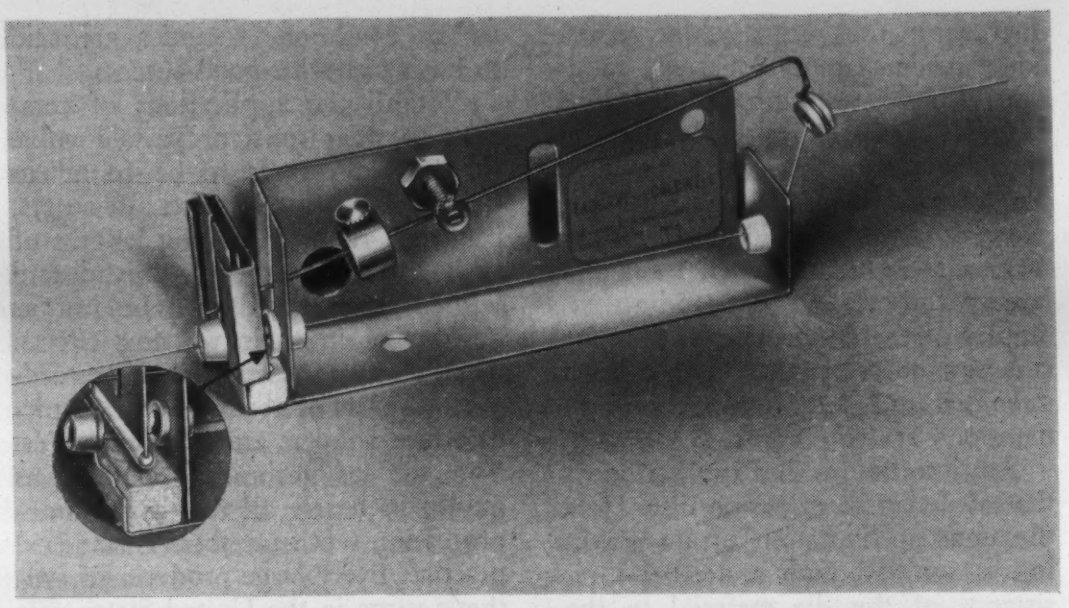
The coefficients of expansion are usually lower than those of most metals. Ceramics are, therefore, dimensionally less affected by changes in temperature than metals. They are nonmagnetic, will not easily conduct electricity, and won't corrode or carbonize.

The chemical resistance of ceramic materials to both alkalies and acids is very good for most compositions, and they can be so formulated that very good service can be expected under specific conditions of chemical attack.

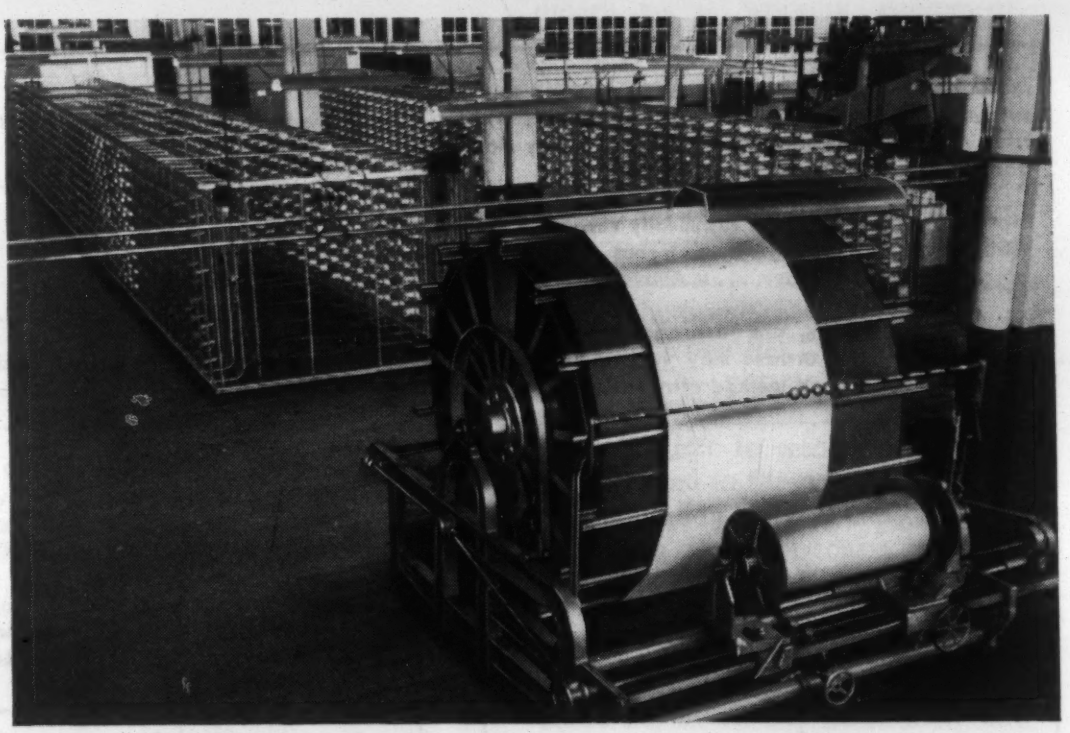
Because of the rather simple techniques required in the forming and machining of ceramics, the costs of parts, by comparison with those made of metals or sintered carbides, are relatively low. The parts are usually formed in a soft, or unfired, state by pressing or extruding and machining. They are then hardened by kiln firing and subsequently ground and lapped to final dimensions. This process has been developed to such a degree that often very little grinding is necessary to obtain close tolerances. This is especially true where the shapes are simple ones, such as flat or round surfaces which lend themselves to grinding and lapping operations.

Applications

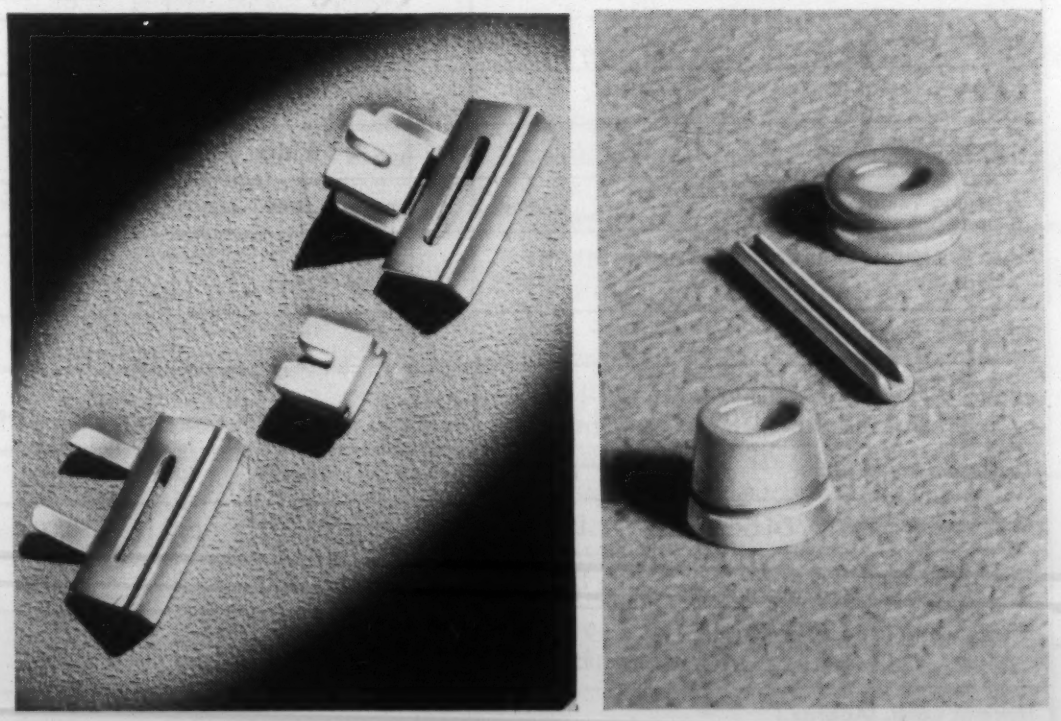
The properties of ceramic materials as outlined above have suggested, and are still suggesting, a steadily increasing number of rather



Here shown is a typical thread guide using ceramic parts. Sectional view shows a ceramic tension bar.



Textile equipment such as this uses up to 1000 ceramic thread guides on each unit.



Typical parts made of vitreous ceramics to meet requirements of dimensional stability and wear.

interesting uses in machine parts. Some readers are undoubtedly familiar with the utilization of technical ceramics for sleeves and arms in counting devices, and pointer stops for gages and dials. Dies for the drawing and extrusion of various materials, including pencil leads and battery carbons, are outstanding examples of the application of alumina ceramics to situations where high strengths and good retention of dimensions are important.

An interesting die application is that of dynamite extrusion dies. Here the unusual limitation of no sparking is coupled with a need for resistance of the die material to the chemical action of the explosive, a set of conditions ceramics are said to have met with good success.

Not all the applications of ceramics to wear resistant parts involve the high pressures to be found in drawing and forming dies. In others, continual rubbing of long lengths of such materials as cord, thread and wire at high speeds can be just as destructive in their wearing effects. Textile guides, parts for wire recorders and parts of reels for motion picture film winders are good examples. The use of technical ceramics as guides in nearly all textile machines processing synthetic fibers is standard practice. Every large producer of synthetic yarns in the United States uses polished technical ceramic thread guides, and many textile manufacturers have adopted these guides as standard equipment in their new textile machinery. The guides are hard and homogeneous, wear gradually, and simply reveal new surfaces of the same character as the old.

An unusual application of ceramics was developed in connection with the polishing of the inside surfaces of cylinders. The cylinders had sharp-edged openings at two points, which ruined the polishing brushes and polishing tools as fast as they came into contact with them. It was found that by plugging the openings with ceramic plugs of such hardness that they could not be affected by the polishing action, a continuous,

Mechanical Properties of Typical

Materials shown have been grouped according to vitrification, impervious dense materials on the left with increasing porosity toward the right, classified by moisture absorption, as follows:

Impervious . . 0 to 0.02% Technically Vitreous 5 to 3%
Vitrified . . 0.02 to 0.5 % Semivitreous . . . . . 3 to 10%
Highly Porous . . . . . Above 10%

Measurements shown are average values from test pieces. Production articles may vary slightly, depending on size, shape and method of manufacture.

		Vitreous Ceramics			
		Fine Texture			
Property	ASTM Test Number	Steatite $MgO \cdot SiO_2$	Titanium Dioxide TiO_2	Zircon $ZrO_2 \cdot SiO_2$	Alumina Al_2O_3
		High Strength Insulators Made to Accurate Dimensions for Radio Frequency Circuits	Ceramic for Polished Thread Guides	Vitrified Ceramic with Excellent Electrical Properties, High Strength and Good Resistance to Thermal Shock	Fine Texture, Extremely Hard, Resistant to Abrasion, Chipping and Corrosion. Best Adapted to Small Size Machined or Pressed Parts
Water Absorption, %	D116–42(A)	0 to 0.02 Impervious	0 to 0.02 Impervious	0 to 0.02 Impervious	0 to 0.02 Impervious
Specific Gravity	—	2.6	4.0	3.7	3.5
Density	—	0.094	0.144	0.134	0.125
Standard Body Colors	—	White	Tan	White	Blue
Softening Temperature, F	C24–46	2624	2642	2624	3182
Safe Temperature at Continuous Heat, F	—	1832	1832	2012	2552
Hardness, Mohs' Scale	—	7.5	8	8	9
Thermal Expansion Linear Coef., In. per In. per °F, 75-1290 F	—	4.8×10^{-6}	4.8×10^{-6}	2.3×10^{-6}	4.3×10^{-6}
Tensile Strength, Psi	D116–42	10,000	7,500	12,000	—
Compressive Strength, Psi	D667–42T	85,000	80,000	90,000	100,000
Flexural Strength, Psi	D667–42T	20,000	20,000	22,000	45,000
Resistance to Impact (½-In. rod), In.-Lb	Charpy D667–42T	5.0	6.5	5.5	6.0
Thermal Cond. (Approx.) Btu/Sq-Ft/Hr/°F/In.	—	2.1×10^{-6}	3.1×10^{-6}	4.1×10^{-6}	6.8×10^{-6}

smooth surface was presented to the polishing tools and the wear on the tools was completely overcome. The polishing operation was greatly speeded, as well.

Wherever there is a requirement for dimensional stability there is a possible application for technical ceramics. Their hardness, rigidity and low coefficients of expansion make them suitable for providing precise, consistently accurate parts. For example, wear plates, or inserts for reference plates, on dial gage stands are often made of ceramics. These are always accurate, and break, rather than chip or deform, when something is dropped on them. The material generally used, a good grade of vitreous alumina ceramic, has a sufficiently fine grained structure to provide a uniformly dense surface that is exceedingly resistant to the wear of every-day usage.

The ability to be ground into flat and parallel parts of permanent, total rigidity has led to the use of ceramics in increasing quantities as machine parts. More and more frequently they are being manufactured into such parts as spacers and mounting plates on business machines, cams for circular knitting machines, tension disks and posts for tension control devices, and for explosion-proof mining equipment.

Wear resistance in combination with another ceramic property, that of low coefficient of thermal expansion, has led to their wide use in work holding devices, jigs and templates in connection with RF heating devices. Here the ceramics generally used are of the refractory type. These have a somewhat greater porosity than the vitreous ceramics and excellent resistance to thermal shock due to a comparatively low coefficient of expansion. They may consist of any of a variety of materials including cordierite, aluminum silicate and zircon. Of these, cordierite has the lowest coefficient of thermal expansion at 1.6 x 10^{-6} in./in./°F over the range 75 to 1290 F. Cordierite, however, has the disadvantage in competition with aluminum silicate in that it cannot be worked on ordinary metal working equipment. For special applications requiring small quantities of materials, a block of aluminum silicate can be machined with little difficulty.

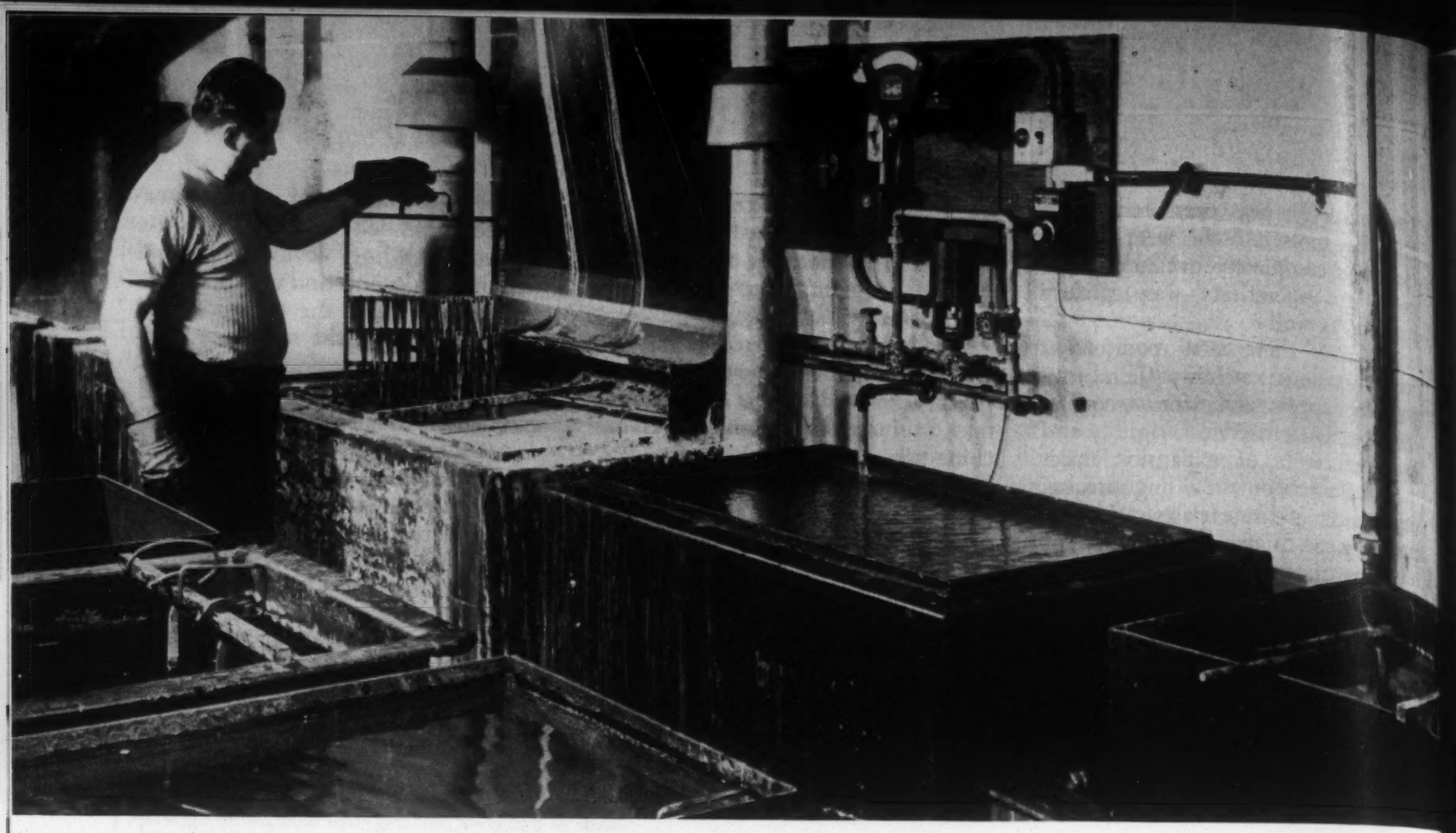
An interesting case history in this connection involves a user of ceramic brazing fixtures who at one time used steel for these parts. Having switched to an aluminum silicate material, it was found that the fixtures: (1) last longer, (2) possess better dimensional stability than steel, and (3) take less time to reach the temperatures desired in the brazing operation due to a lower heat capacity than steel. The results, of course, were less distortion, longer life of the fixtures, and better production.

The list of applications for technical ceramics as wear resistant parts could be drawn out indefinitely and might include such other products as the components used in the drawing and twisting of slivers of paper in the manufacture of paper twine, or the compressive components in the continuous production process for coating certain wires at high speeds.

Still newer fields are being introduced with the advent of combined ceramics and metal parts. These combinations generally utilize the rigidity and dimensional stability of ceramics more than they do wear resistance. At present, the fastest growing demand for such combinations is in ceramic shafts for mounting electronic devices, such as tuning condensers. The rod is totally and permanently rigid, can be economically fabricated to close tolerances, and force fitted with metal sleeves and bearing races to precise dimensions. The advantages of these combined materials are attracting the attention of nearly every manufacturer of electronic equipment.

Technical Ceramics

Made From Natural Stone	Refractories			
	Medium Grain	Fine Texture		Granular
Aluminum Silicate	Cordierite $2MgO \cdot 2Al_2O_3 \cdot 5SiO_2$	Zircon $ZrO_2 \cdot SiO_2$	Alumina Al_2O_3	Zirconium Oxide ZrO_2
Good Electrical and Heat Resistance, Excellent for Close Tolerances. Available in Larger Sizes Than Any Other Grade of Lava	Low Coefficient of Expansion, High Resistance to Heat Shock. For Heating Elements, Thermocouple Insulators and Burner Tips	Very Fine Grain Refractory with Good Resistance to Heat Shock. Suitable for Firing Plates and Supports, Brazing Jigs, Etc.	Easily Degassed Refractory with Good Electrical Resistance at High Temperature. Porous Body Principally Used for Vacuum Tube Insulators	Refractory Body Excellent for Heat Shock. Made Only in Plates, Rods and Simple Shapes Manufactured by Pressing or Casting Methods
2 to 3 Technically vitreous	10 to 15 Highly porous	8 to 14 Highly porous	12 to 18 Highly porous	12 to 16 Highly porous
2.3	2.1	2.9	2.4	2.9
0.085	0.076	0.105	0.087	0.106
Pink	—	White	White	Orange
2912	2606	2930	3272	4352
2012	2282	2462	2552	2912
6	7	—	—	—
2.0 x 10^{-6}	1.6 x 10^{-6}	2.9 x 10^{-6}	4.0 x 10^{-6}	4.6 x 10^{-6}
2,500	3,500	—	—	—
20,000	40,000	16,000	11,000	11,000
9,000	8,000	13,000	10,000	4,000
3.3	2.5	5.0	3.0	4.0
1.02 x 10^{-6}	1.02 x 10^{-6}	1.02 x 10^{-6}	1.36 x 10^{-6}	1.36 x 10^{-6}



Typical arrangement of tanks for black oxide finishing.

Low Cost Black Oxide Finish Produced on Steel by Chemical Dip Method

This attractive, durable and corrosion resistant finish is suitable for a variety of applications, including machine parts, bearings, gages, aircraft engine components, and similar products.

by A. J. MITCHELL, President, The Mitchell-Bradford Chemical Co.

● WHEN NEW PRODUCTS are designed and old ones redesigned, or wherever a finish is needed, black oxide should be given careful consideration when the following characteristics are required: (1) attractive black finish; (2) corrosion resistance, depending upon whatever final finish dip is used; (3) lubricating qualities of the finish due to its ability to absorb and adsorb the final finish dip; (4) non galling surface; (5) no dimensional changes; and (6) economy and ease of application. Because of the simple equipment required and the low cost of the applied finish, black oxide has replaced many other type finishes and is used on items which heretofore were left unfinished due to cost.

The black oxide finish on steel is composed essentially of the black oxide of iron Fe_3O_4, a combination of FeO and Fe_2O_3, and is formed by several methods. These are the browning process, carbonia process, heat treatment, and what is now commonly known as the aqueous alkali-nitrate method. The aqueous alkali-nitrate process is most frequently used, and this article will be primarily concerned with it. Only a brief description of the other methods will be given.

The black oxide finish is produced in the aqueous alkali-nitrate method by the immersion of the metal in a highly alkaline solution containing strong oxidizers and other rectifying chemicals which at a specific concentration and temperature react with the iron in the steel to form the

black oxide of iron (Fe_3O_4). Because this is a direct reaction at the surface of the steel, there is no displacement of metal but merely a change in chemical structure. Therefore, for all practical purposes there is no change in dimensions. This change in chemical structure from iron to black iron oxide is usually to a depth of approximately 0.0001 in. Prolonged immersion in the blackening solution for 2 hr or more will produce an approximate maximum depth of 0.00015 in. Producing this extra depth, however, can be deleterious to the finish due to the slight solubility of iron in a highly concentrated alkaline solution at the temperature used in a blackening bath. The blackening solution will dissolve some of the iron, leaving a loose film of black iron oxide which can be very easily scratched off.

The statement "practically no dimensional changes" is used because in reality tests showed that there was actually a build-up of about 5 millionths of an in. This small increase seldom has to be taken into consideration. In transforming iron to black iron oxide, there naturally is a change in volume. Because the blackening solution will dissolve a small amount of iron, we can rightfully assume that the volume of iron lost by its solubility in the blackening solution is compensated for by the increase in volume resulting from the oxidation of iron to iron oxide. This change presumably is not exactly equal, but is so close that the actual build-up from the original size is only 5 millionths of an in.

Many uses for the black oxide finish have been found because of the infinitesimal dimensional changes. These include finishes for close tolerance machine parts, bearings surfaces, gages, etc. In fact, because of this particular advantage, there has been a patent issued for the use of black oxide finish for gages (Patent #2355007).

Equipment and Procedures

The equipment required for applying a black oxide finish to steel includes: (1) hot alkali cleaning tank, (2) hot water rinse, (3) blackening tank, (4) cold water rinse, and (5) final finish dip—this can be various types of oils, waxes, lacquers, etc.

Cold rolled steel plates can be used for the tanks as the solutions employed have little corrosive effect on the steel. Tanks for the hot solutions, such as the rinses, alkali cleaners and blackening solutions, can be heated by gas, steam or electricity.

Adequate ventilation for at least the blackening solution should be used. This can be taken care of by window fans if the tanks are suitably placed. Another method is to equip the tanks with exhaust casings along one or more edges with ducts leading to a suitable exhaust fan.

A temperature controller should be used to maintain the operating temperature of the blackening solution. Automatic control is obtained by means of an indicating temperature controller, an electric lock in relay and a ½-in. motor operated valve. Because a blackening solution is operated at a specified boiling temperature, which is determined by the proportion of blackening salts to water, it is practical to maintain this operating temperature by the addition of water to replace that which gradually boils off. It is this loss of water by evaporation which causes a rise in boiling temperature. By the use of the temperature controller tied in with the motor operated water valve, the proper temperature can be constantly maintained.

There are many variations of the basic black oxide processing procedure. Sometimes it is necessary to use a hot water rinse in addition to the cold rinse after the blackening solution. At other times it is necessary to add an acid pickling solution after the rinse following the alkali cleaning, and introduce one or two rinses prior to the blackening solution. However, these added rinses, etc. are the exception rather than the rule, and in most cases the basic five tank steps are all that are required.

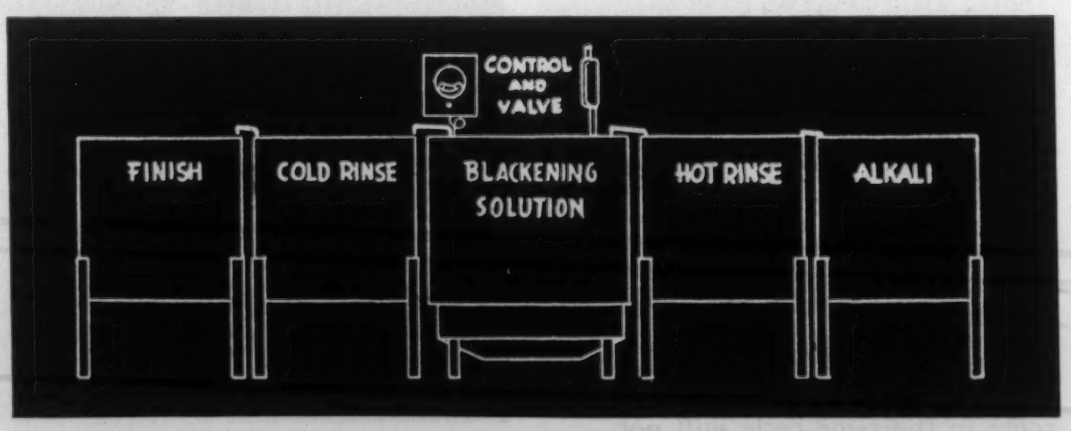
Black oxide processing is also readily adaptable to full automatic finishing equipment and there are a number of installations in use today. It is, however, very important that engineers qualified in the processing procedure analyze the type and quality of work to be processed so that the best blackening procedure can be incorporated in the set up.

If the black oxide surface is to be used as a bond for paint, enamels or lacquers, the following procedure should be used: (1) alkali clean; (2) hot rinse; (3) blacken; (4) cold water rinse; (5) chromic acid dip—approximately ½ to 1 oz chromic acid per gallon of water, approximately 5-min immersion; (6) hot rinse and dry; and (7) paint.

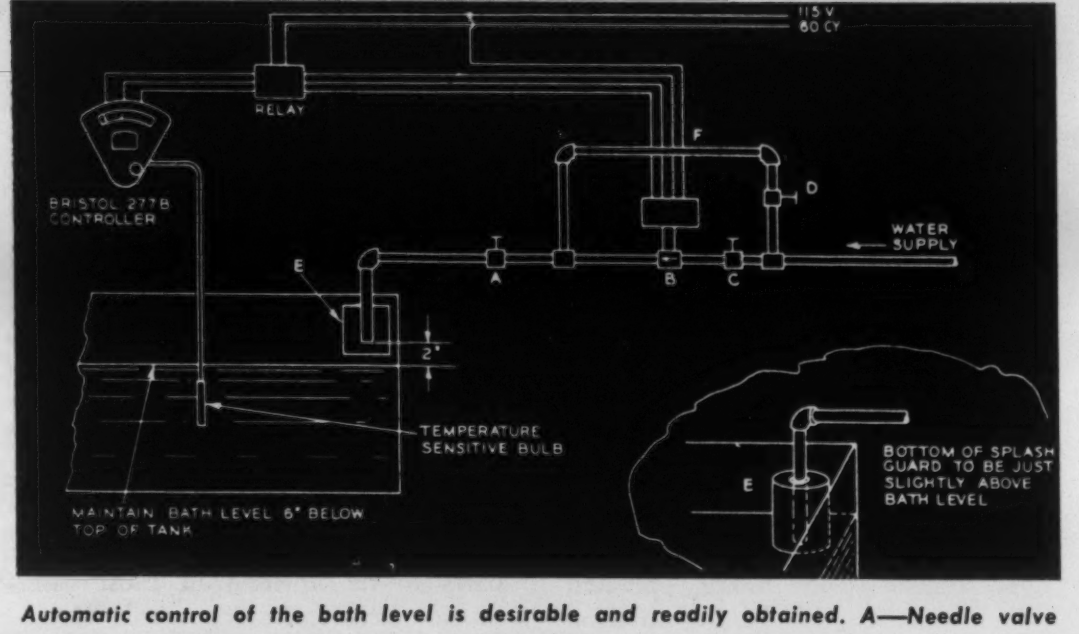
In contrast to electroplating, the parts to be finished in most cases do not have to be separated. Therefore, a great variety of parts can be processed in baskets and a large volume of work can normally be handled in a relatively small volume of solution. In some cases racks must be used while in others, where the work is absolutely flat, tumbling barrels can be employed. The handling equipment can be made from cold rolled steel or, in the case of baskets, plain steel mesh. If there is a pickling operation included in the processing line, stainless steel should be used for baskets, racks, etc., if possible.

The Blackening Solution

In the operation of a blackening solution for steel, it is important that iron and steel be the only metals immersed in the solution. Other metals contaminate the solution, and in many cases cause vigorous chemical reaction. Because of the high alkalinity of the blackening solution, zinc, aluminum, cadmium, galvanized steel and similar materials should never be immersed in it. Copper and copper alloys should not be processed, either. However, the small quantity of copper alloy present in brazed steel parts will not usually cause excessive contamination of the blackening solution.



The aqueous alkali-nitrate dip process requires a minimum of equipment.



Automatic control of the bath level is desirable and readily obtained. A—Needle valve B—Motor-operated control valve. C and D—Globe valves. E—Splash guard. F—By-pass.

In recent months a new type proprietary blackening salt has been placed on the market which has many advantages, including self rectification. Because of this feature, it will not only counteract the normal build up of colloidal red iron oxide, but will also counteract a large amount of contamination resulting from the processing of brazed parts. It will also blacken heat treated parts more easily; operates at a lower temperature; has low concentration of salt to water, resulting in less dragout; easier rinsing; and lower cost for replenishment of dragout.

A freshly mixed blackening solution when started in full production often requires a "breaking in" period, although under certain circumstances this is not necessary. However, during this period, which will run from 24 to 48 hr, erratic coloring or blackening will be experienced if the solution is used for continuous full production loads.

We have found through extensive investigation that a blackening solution, when first mixed, contains approximately 2% sodium carbonate, which is an impurity in the chemicals used. During a "breaking in" period the percentage of sodium carbonate steadily increases until it reaches 5 to 7%, beyond which concentration the sodium carbonate content will not increase. This is the end point of the "breaking in" period and the blackening solution will then function properly. During this "breaking in" period the solution will blacken erratically to the extent that some pieces in one cycle will blacken while some in the same cycle will not.

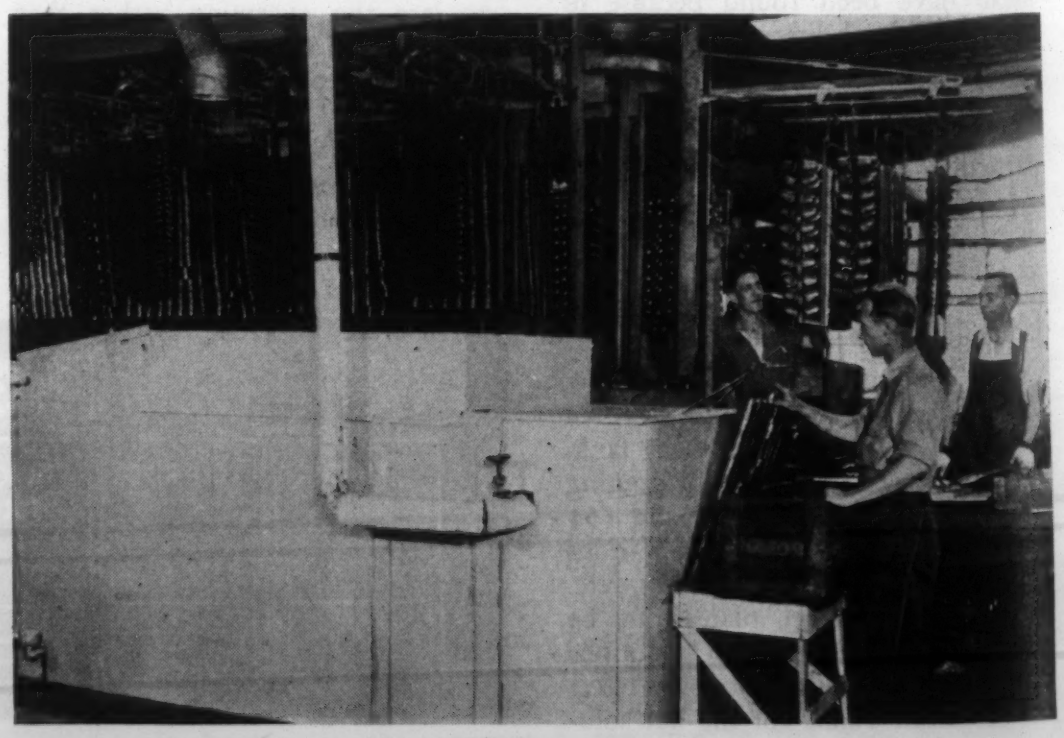
If this particular situation arises, either the processing loads can be cut down or the solution can be allowed to boil for approximately 24 hr without processing any work. We have found that for all practical purposes cutting down on the processing loads will be sufficient. As already stated, this particular "breaking in" period does not always appear. This might be explained in two ways: The new blackening solution is not loaded to capacity for the first few days and thus the "breaking in" period is not noticed, or the lower quantity of carbon dioxide in the water in certain areas of the country minimizes the formation of sodium carbonate.

After preparing the initial solution by mixing the required amount of blackening salts and water to obtain the proper concentration to boil at the recommended operating temperature, it is not usually necessary to use any analytical control of the solution. The daily replenishment of the dragout by the addition of blackening salts with the required amount of water will maintain the oxidizing strength of the solution.

The amount of blackening salts and water required to replenish this loss from dragout can be established as follows: A marker arrangement is used on the tank to designate the normal working level of the solution, which is normally 6 in. from the top of the tank. After a half day's or a full day's production, depending upon the volume of work handled, the drop in working level of the blackening solution should be measured. Assuming that the drop in level was 1 in. and that 1 in. of depth in the tank being used represented 3 gal of blackening solution, and also that the particular type of blackening salts being used required $6\frac{1}{2}$ lb to make a gal of solution, $19\frac{1}{2}$ lb of salts would be required for replenishment. This amount of blackening salts should then be added to the solution and water added to raise the solution to the working level indicated by the marker. Any small error made in these additions will be compensated for by the automatic temperature controller.

Applications

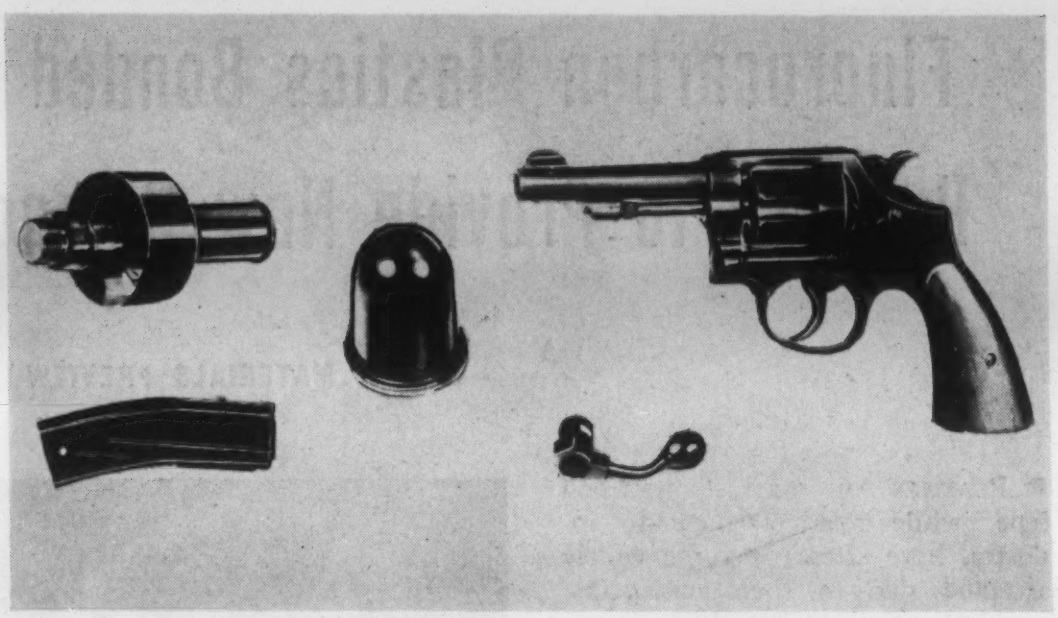
Black oxide finishes began to come into prominence commercially prior



Automatic equipment permits the handling of large quantities of parts with minimum labor.

to World War II. A large number of manufacturers were starting to use this type of finish, especially on toys, screws, sporting firearms, machine parts, wire staplers, and similar products. During World War II, many of these applications were naturally curtailed, but the black oxide finish immediately was applied to gun parts, grenades, buckles and a thousand and one other type military applications. Government specifications, such as 57-0-2C, type III and 51-70-1A, item 22.04, were set up covering the requirements for the black oxide finish. Because of the greater use of the black oxide finish during this period its advantages became widely known. After the war, the black oxide finish was used again for civilian production, and more and more new uses were developed. The automobile, machine tool, appliance, camera and optical manufacturers and a number of similar industries found many applications.

A very important use for the finish was found on certain components of gasoline aircraft engines and jet engines. As a result, specifications were set up especially for these particular applications.



The black oxide finish is attractive and durable.

Other Blackening Methods

Browning Process—The browning process is basically a rusting process. The metal surface, after having been thoroughly cleaned, usually in a hot alkali cleaner, is swabbed with an acidic solution. There are a large number of formulations which can be used for this solution. After drying in a dry atmosphere at around 170 F, the pieces are subject to approximately the same temperature, but in an atmosphere of practically 100% humidity for about 1½ hr. Under these conditions rust is formed on the metal surface. Following this treatment, the surface is rubbed down to remove the loose rust. This rusting and rubbing down procedure is carried out three or four times, after which an oil dip is applied.

Carbonia Process—The carbonia process is accomplished usually by placing the pieces in a rotary furnace heated to 600 to 650 F. In this furnace a carbonaceous material, such as charred bone, is introduced together with a thick oil known as Carbonia oil. The pieces remain in the furnace for about 4 hr. The door or cover to the furnace is occasionally opened and closed to allow recirculation of air. After the parts have been subject to this treatment, they are removed and immersed in oil. When cool, they are removed and allowed to drain. This finish is essentially the black oxide of iron, but because the metal surface is in contact with carbonaceous material and oil, the carbon penetrates slightly into the surface of the metal.

Heat Treatment Methods—The heat treatment procedure can be accomplished by oven heating, salt bath immersion, or a steam process.

In the oven heating procedure, the metal is placed in a heated oven operating at a temperature between 600 and 700 F and oxidized to a bluish black oxide. Since the shade of color is dependent not only on the temperature but also on the analysis of the steel, it is usually difficult to maintain a uniform finish. The color produced is also quite thin.

In the molten salt bath method, the oxide finish is obtained in several ways, depending upon the manufacturing or processing requirements.

1. A nitrate salt mixture is used as a molten bath at 600 to 700 F. In order to produce a good color by this method, it is necessary that the metal be clean and have no oxides on the surface. Under these conditions, if the metal is immersed in the molten nitrate salt bath, a blue black color will be obtained.

2. The same molten bath with or without modifications will produce a blue black color on the metal surface if incorporated into an austempering heat treatment procedure. The range of color is dependent upon the formulation and temperature of the molten tempering bath. In this instance the metal to be heat treated is heated to the proper hardening temperature in a molten neutral hardening bath, after which it is removed and quenched in the tempering bath. The neutral salt bath will prevent oxidation of the metal surface during the heating period. Also during transfer from the neutral bath to the tempering bath, the metal will be covered with a thin layer of salts, which will prevent oxidation until the material is immersed in the tempering bath. When the pieces are removed from the molten tempering bath and rinsed in clean water, a good black oxide finish will be obtained if the procedure has been carried out properly, and of course, the right type of salt mixture used.

3. A molten alkali-nitrate mixture can also be used at 900 to 950 F to produce a black oxide finish. However, this method is extremely hazardous and is not normally recommended.

4. A molten dichromate bath is used for blackening stainless steels and produces an excellent black oxide finish on these metals. This method is considered the most consistent and easiest to use at the present time for the blacking of stainless steels.

In the steam process, the steel is placed in a retort and heated to a minimum temperature of 600 F. At this temperature, the retort is purged with steam. In the case of high-speed steels, the temperature is then raised to 1000 to 1050 F, in order to carry out the tempering operation at the same time.

Fluorocarbon Plastics Bonded to Metals and Rubbers to Provide New Composite Materials

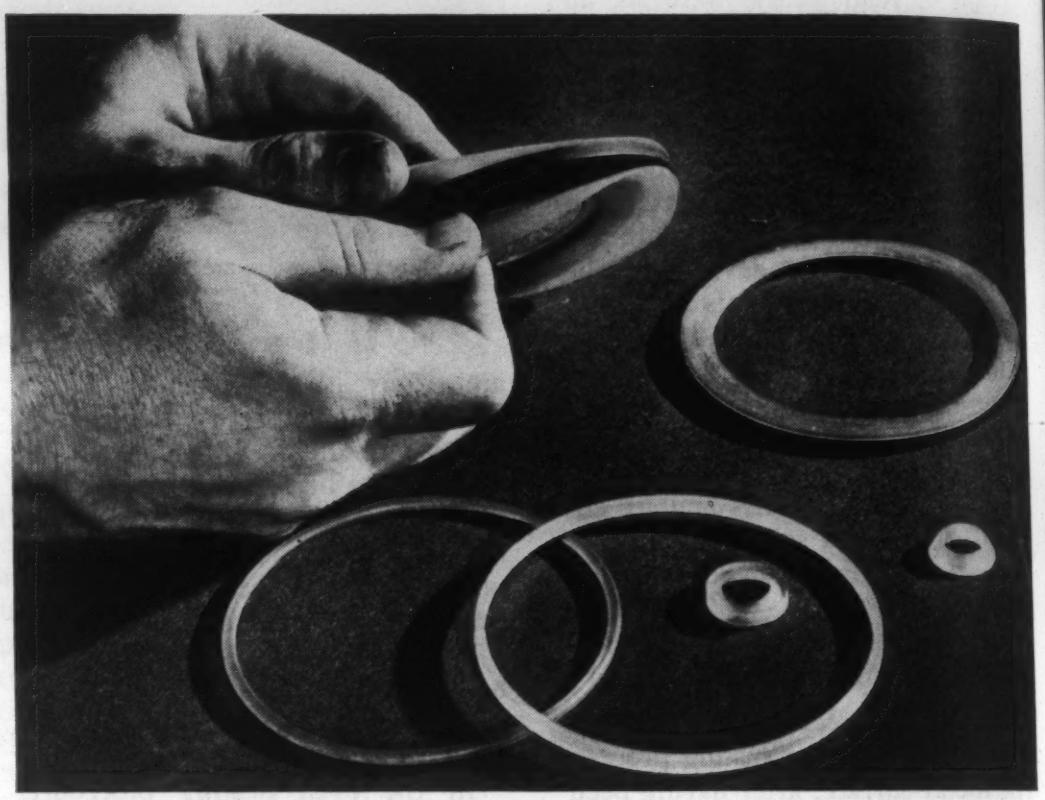
—A NEW MATERIALS PREVIEW

● PLASTICS OF THE fluorocarbon type, while relatively new to industry, have already become widely accepted due to their remarkable qualities. Their outstanding characteristics include mechanical stability over a wide temperature range, high resistance to most corrosive media, and high dielectric strength. The two commercially available plastics in this group are Teflon, made by E. I du Pont de Nemours & Co., Inc., and Kel-F, a product of The M. W. Kellogg Co.

The two plastics materials are used extensively in the chemical and electrical fields in the various forms in which they are available. However, there have been restrictions on their use for two reasons. First, the materials are much more expensive than other plastics and, therefore, could not be used indiscriminately. Second, no existing cement could be used to bond these materials to themselves or to other materials.

Now through research done by the Connecticut Hard Rubber Co. under contract with the U. S. Navy Bureau of Aeronautics, a practical bonding process has been developed which permits Kel-F and Teflon to be joined to many other engineering materials. Tests on joints with the plastics applied to copper, aluminum and rubbers, including the silicones showed the bond to be of extremely high strength.

For the present, bonding will be done in the plant of The Connecticut Hard Rubber Co., in New Haven, Conn., who have had considerable experience bonding in the preparation of silicone-fiberglass and other laminates. The bonding process is most easily applied when the Kel-F or Teflon is in the form of a plain sheet; but laminates are not restricted to sheet form, other simple curvatures being practical. The process has not yet been developed to the point where articles of complicated shapes can be coated, although development work on this problem is continuing.



Fluorocarbons' unusual properties make them suitable for many severe service applications. (All photos courtesy M. W. Kellogg Co.)

In addition to permitting the use of smaller quantities of the plastics, the development of a bonding process opens several other possibilities, not the least of which is the ability to combine materials whose properties complement each other. For example, neither plastic has sufficient resilience for many gasketing applications. However, when backed with a silicone rubber or other type of rubber, an excellent gasket can be provided.

It has been observed that considerable improvement in abrasion resistance of the relatively hard plastic is obtained when it is backed with a resilient material such as rubber.

Before we go into the anticipated uses of Teflon and Kel-F when combined with other materials, it might be well to review, briefly, some of their outstanding properties. Here they are:

Teflon — Chemically, Teflon is known as polytetrafluoroethylene. It is useable over a temperature range of from –320 F up to about 500 F for certain applications. The plastic retains its chemical inertness over this range. There is no known solvent for Teflon, and it is attacked only by fluorine and chlorine trifluoride at high temperatures and pressures and by molten alkali metals. Teflon has good arc resistance and a dielectric strength of 1000 to 2000 volts per mil. It also has a low dielectric constant (2.0) and a low power factor over a frequency range of 60 to 10^6 cycles.

Teflon is nonadhesive, weathers extremely well, is water repellent, and has exceptionally low water absorption tendencies. Its tensile strength ranges from 2000 to 4500 psi. The material deforms rapidly under a given load while under compression, but has a plastic memory and will return to approximately the

original shape when the load has been removed. Complete return can be achieved by heating the material to its transition temperature. Teflon has some tendency to cold flow, but this can be overcome by proper design.

Kel-F—Kel-F is the commercial name of a polymonochlorotrifluoroethylene resin. It, too, retains its properties over a wide temperature range from —330 F to 390 F. This plastic is less subject to cold flow. It deforms under compression, but springs back when the load is removed.

For most purposes, Kel-F is classed as chemically inert, being unaffected by organic solvents, strong acids, alkalies and oxidizing agents. Too, it has excellent weathering characteristics. Tensile strength is about 5700 psi. Its dielectric constant is 2.8 to 2.3, dielectric strength 390 to 5000 volts per mil.

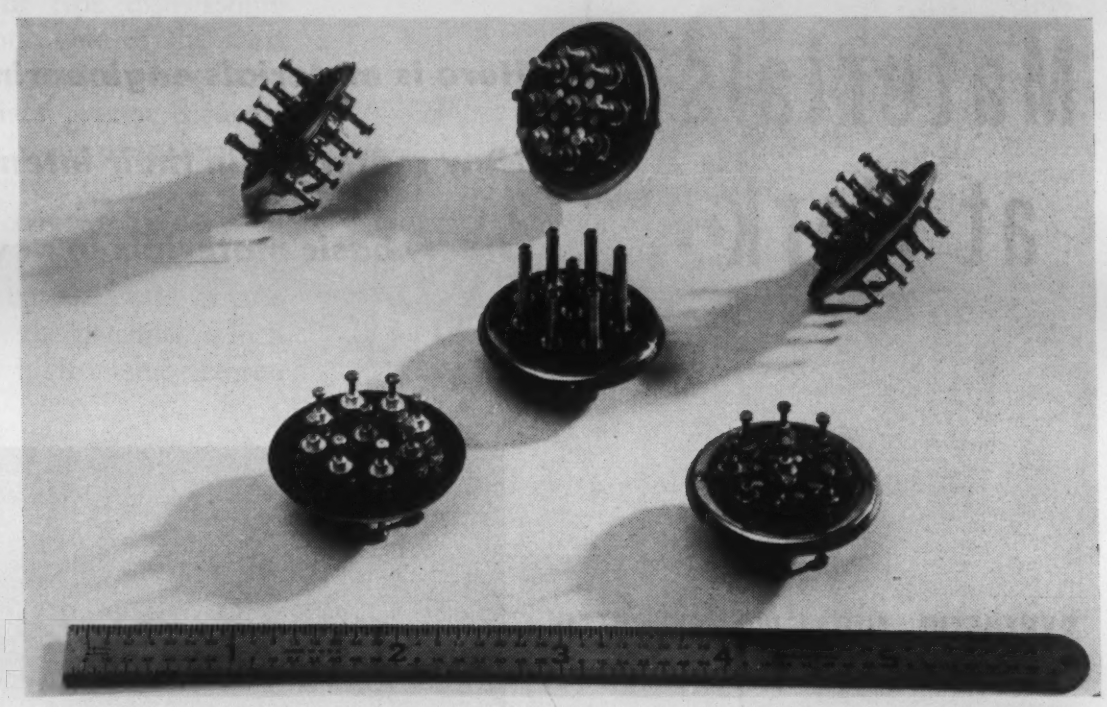
Silicone rubber is the only rubber which can match Kel-F and Teflon in high temperature resistance. No known rubber or plastic can match them in low temperature resistance.

Applications

Three important areas of use are suggested for the bonded Kel-F and Teflon combinations: chemical, electrical and aircraft.

In chemical applications, the plastics can be bonded to materials used for tanks, kettles and piping where their excellent resistance to corrosion can be used to advantage. A resilient interlayer can be included if desired. In addition, they can be used to make resilient chemical-resistant gasketing when used in combination with silicones or most any type of rubber. An excellent application would be a combination fiber glass cloth-silicone-Kel-F- or Teflon-faced belt for conveyor use where extreme conditions of heat (to 500 F), cold (to —100 F) or solvent or chemical exposure might be encountered. The plastic coating would render such a belt impervious to virtually anything except molten alkalis or fluorine at high temperatures.

Both Kel-F and Teflon are already widely applied in electrical applications, but additional uses are anticipated. Teflon combined with copper could be used for condensors and possibly in wave guide applications. Another possibility is to make the equivalent of printed circuits by etching away unwanted copper for the copper-backed Teflon.

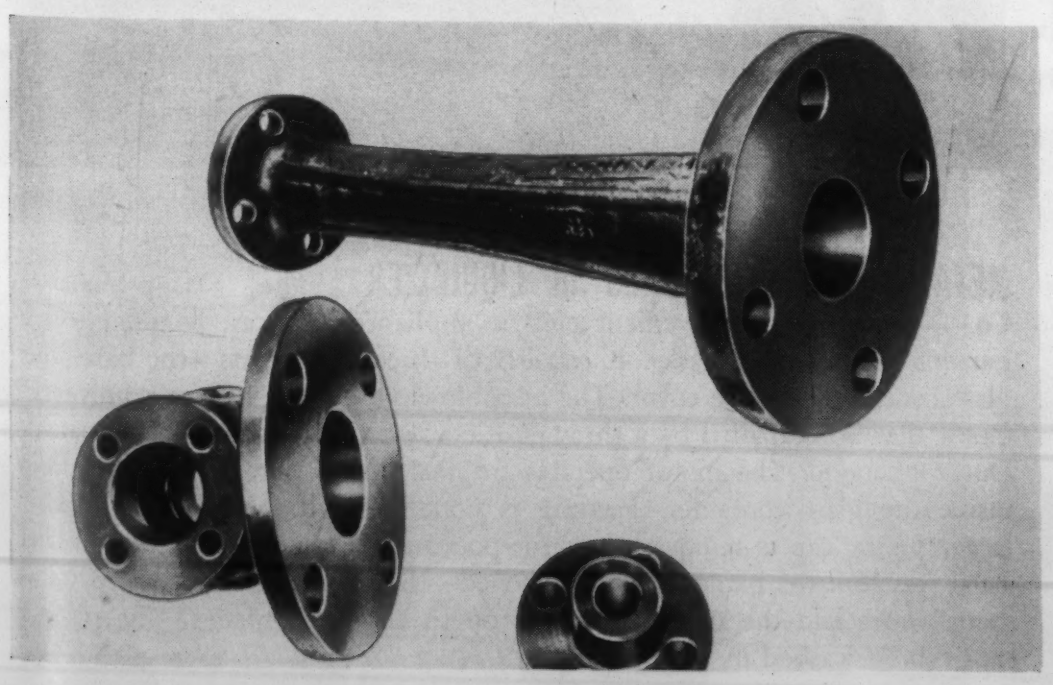


Fluorocarbon plastics are now being used in the electrical industry for parts such as these hermetically sealed transformer terminals.

Because of their excellent weathering characteristics, the materials are being suggested as a likely answer to the rain erosion problem in aircraft applications, as for example, on helicopter blades. For this type of application, the laminates would provide a hard surface with some resiliency. In aircraft there are also many applications where the range of temperatures encountered is so great that the stability of Kel-F and Teflon could serve to advantage. Likewise, they might be the solution to the problem of handling high-octane aircraft gasolines and aromatics. Although expensive, these materials may now be considered for such applications because of the possibility of bonding thin films of them to other cheaper materials.

Currently sheet Teflon and Kel-F is limited to a width of approximately 24 in., but wider sections could be provided were sufficient demand in evidence. When used in conjunction with some other backing material, sheets of the plastics could be as thin as 0.001 or 0.002 in. and be suited for most uses. Greater thicknesses would be employed in certain instances to insure against possible porosity of the plastics. Likewise, sandwich construction can be employed where desired. Aside from the element of cost, there is a possibility that silicones, Kel-F and Teflon may be in short supply in the next two years. The importance of the new technique for utilizing thin films of the two plastics as protective coatings for more available materials is obvious.

Many uses for bonded fluorocarbons should be found in the chemical field.



Materials at Work

Here is materials engineering in action . . .

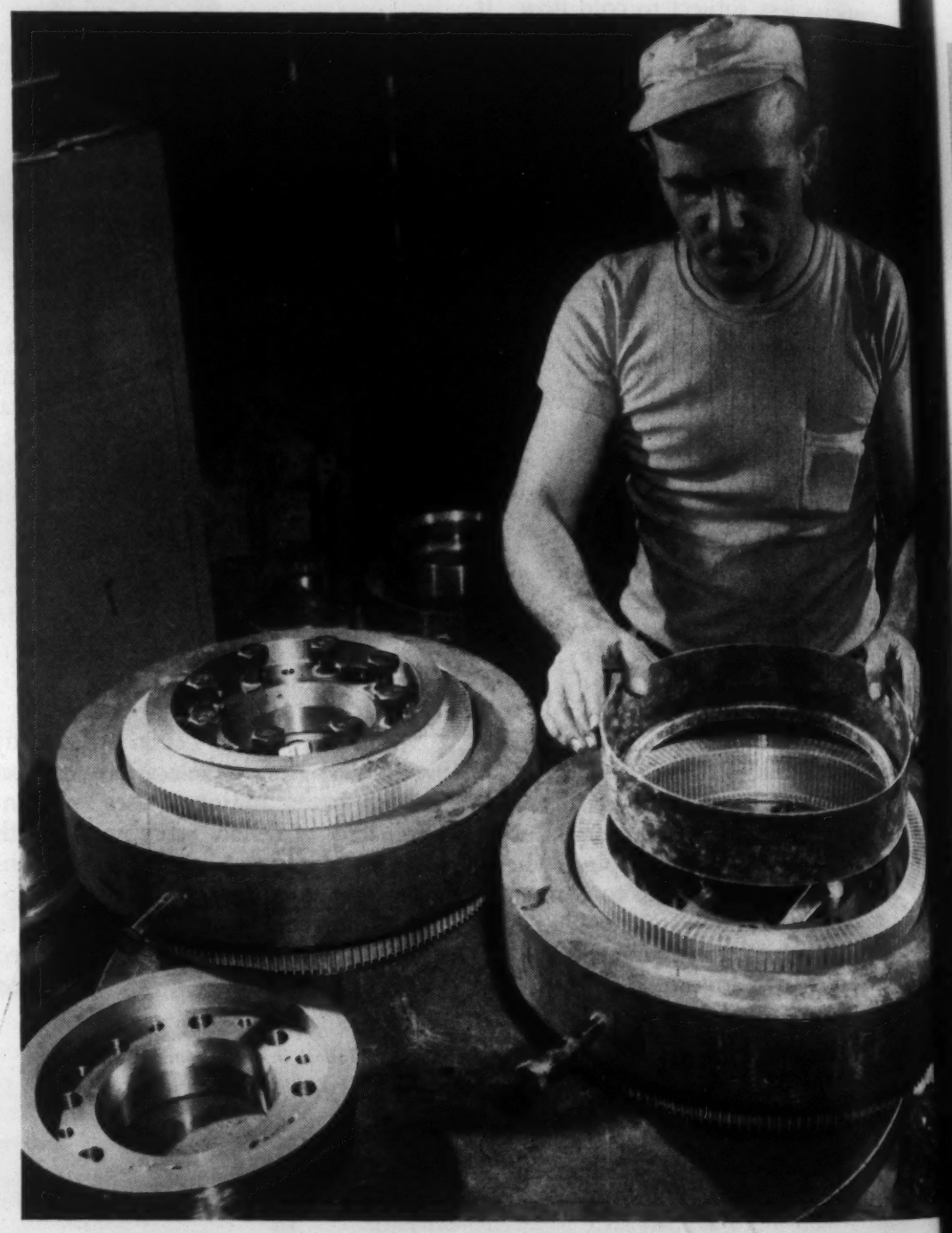
New materials in their intended uses . . .

Older, basic materials in new applications . . .

SYNTHETIC MICA - BONDING RESIN

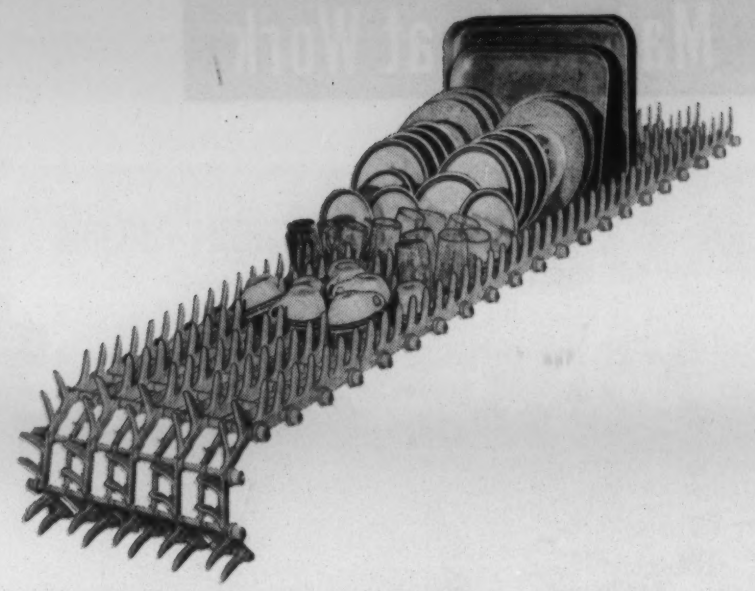
Westinghouse has developed a synthetic resin to improve the performance of electric commutators. Shellac has been the conventional way of bonding the mica for commutator vee rings. Shellac is the excretion of insects that feed on Asiatic acacia trees. The product is variable, according to kind of insect, the weather, amount of rain, even the altitude. In spite of the best processing control, an element of variability in shellac-bonded insulation remains. Further, increasing duty of commutators, such as in transportation service, has made a better bond desirable.

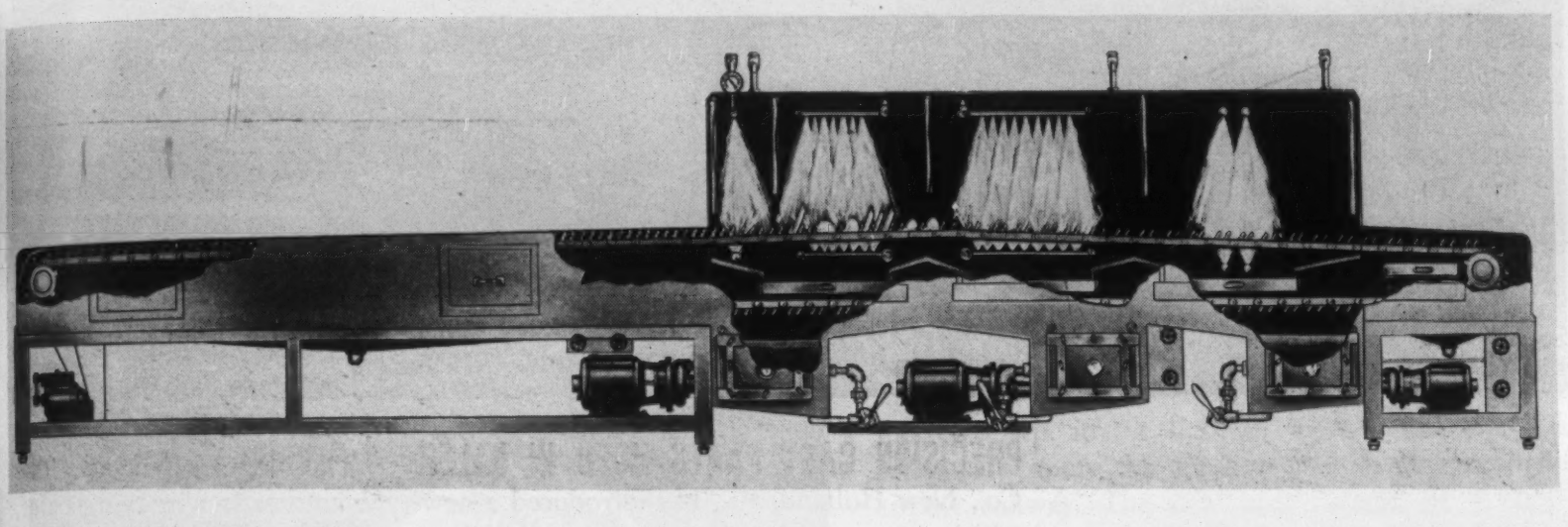
The new synthetic bond, which is still known only by a materials number, is of the vinyl type. Vee rings bonded with the new resin are made in the same way and with the same equipment as before. However, the product is both more permanent and more uniform. The tendency for mica flakes to slip over each other under the operating conditions of high pressure and high temperature is greatly lessened. The result is a commutator dimensionally more stable. It retains the required surface smoothness for good brush tracking and commutation under all conditions of speed and temperature.



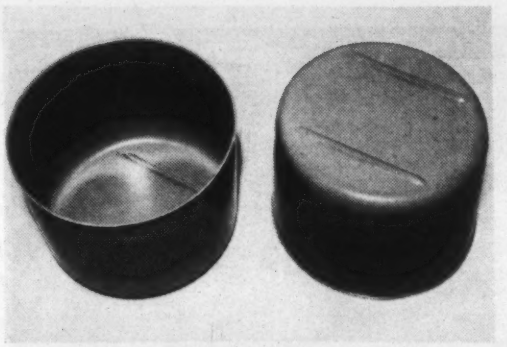
METALS AND NON-METALS IN LIQUIDIZER The Knapp-Monarch Co. Liquidizer is a convenient electric appliance that can be used for a number of household tasks. It consists of three basic parts—the base, the glass container and the cover. The base of white enamel houses a universal motor that is controlled by a three-position switch molded of heat resistant Durez phenolic. The motor operates surgical blades permanently installed inside the glass container. Feeding is done through the white cap. The larger plastic cap is removed only for pouring. The glass is washed in the usual way, but the blades are not removed—the container is just filled with soapy water and the motor is turned on to clean the blades. The plastic caps can be washed in water, however.

NYLON DISH CONVEYOR Blakeslee & Co., of Chicago, has designed a rackless conveyor type dishwashing machine for commercial establishments. One of the most interesting engineering features of the machine is a nylon injection molded conveyor which gives greater economy and efficiency. Dishes, cups and bowls are placed on the conveyor in an up-right position to provide thorough washing, rinsing and final rinsing. The conveyor is designed so that the dishes do not touch metal, thereby preventing chipping and marking the china. Even glassware can be handled safely. No racks are used in the machine, which uses a final rinse in water at 180 F or higher temperatures.

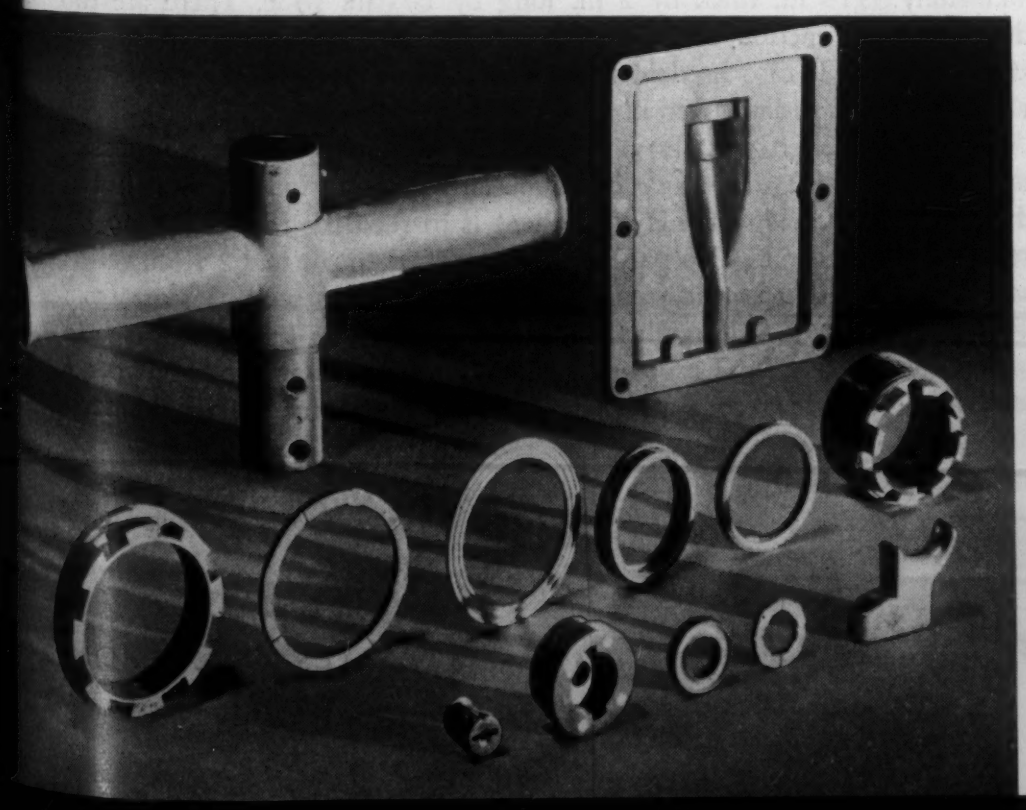


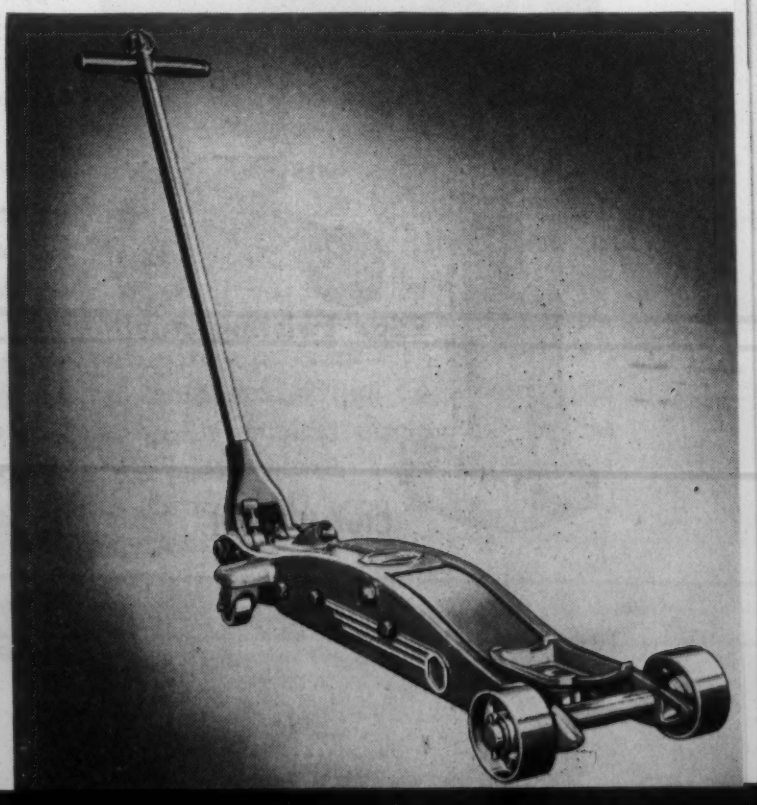


FIBER GLASS DUST BOWL Auburn Button Works, Inc., Auburn, N.Y., is molding this new, lightweight fiber glass dust bowl for the Lewyt Corp., Brooklyn, manufacturers of the Lewyt vacuum cleaner. It was formerly made of steel. The new cannister, which has three times the specific impact strength of steel, will not chip or dent, and, because of the resonance-dulling characteristics of fiber glass, there is less noise when the cleaner is operated. The use of plastics reduces by 3½ lb the total weight of the cleaner. The Lewyt Corp. recently started a $250,000 re-tooling program to manufacture the cleaner with alternate materials, developed chiefly around the use of fiber glass combined with polyester.

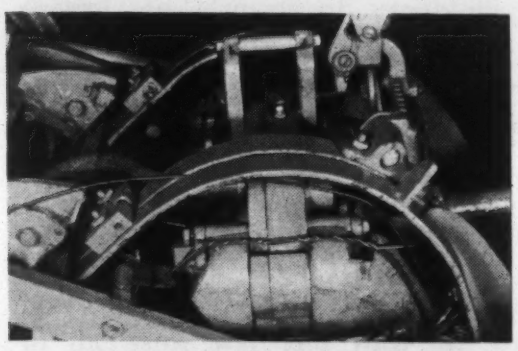


ZINC DIE CAST JACK PARTS This 4-ton service jack, manufactured by the Blackhawk Manufacturing Co., is a heavy duty application of zinc die castings. The die castings in this assembly do not do any of the actual lifting, but automobile mechanics are not gentle in their handling of heavy duty tools. This model is in constant use in busy garages and service stations since it handles all cars and light trucks. It will lift up to four tons to a height of 24¼ in. Several of the zinc die castings can be identified on the jack—the handle, finger control lever and light housing. The other castings, with one exception, are hidden from sight in the hydraulic lifting mechanism. The exception is the lock handle (this locking feature prevents tampering or removal of the jack when it is under a load). The material used was furnished by the New Jersey Zinc Co.

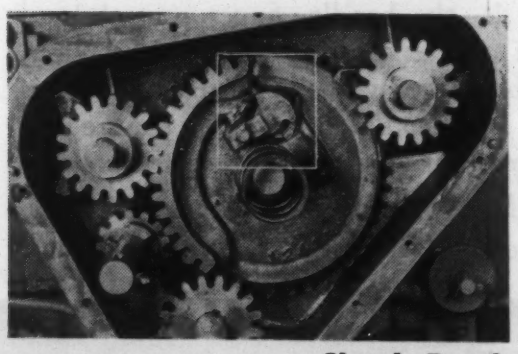




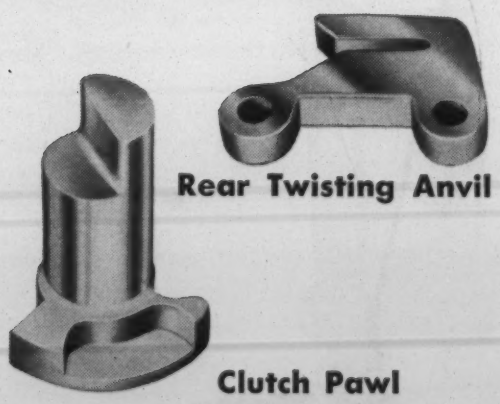
Materials at Work



Wire Twisting Mechanism



Clutch Pawl



Rear Twisting Anvil

Clutch Pawl

PRECISION CAST PARTS USED IN BALER The New Holland Machine Co., New Holland, Pa., has introduced a new type automatic wire-tying baler, which uses precision investment castings at two principal sub-assemblies of its construction. These parts, manufactured by the Microcast Div. of Austenal Laboratories, are a clutch pawl, and four twister anvils—two in the front and two in the rear of the wire twisting mechanism. Each component is made from AISI 4615 carburizing grade steel. Since these pieces must withstand great wear, hardness is an important consideration.

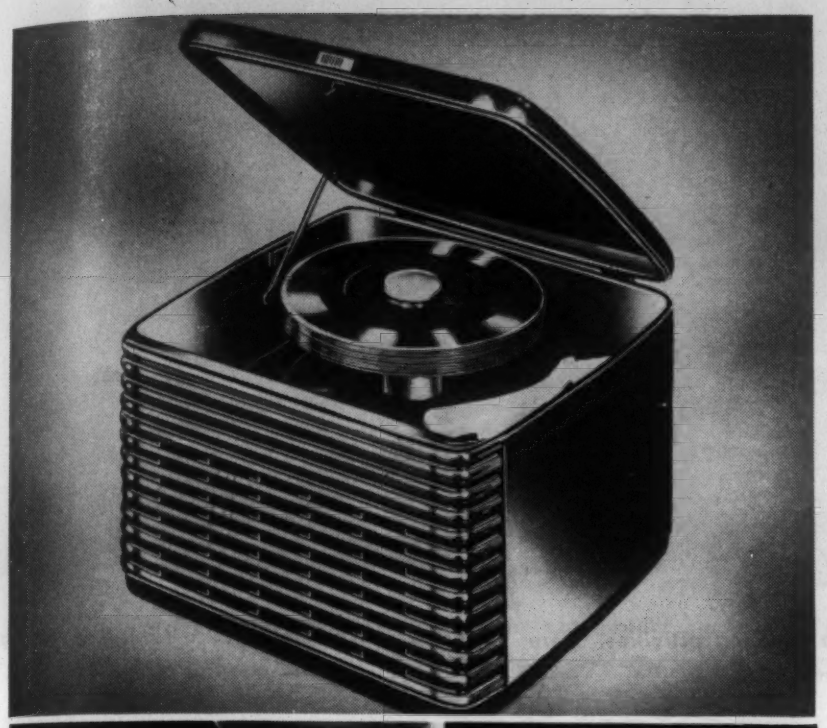
Precision castings were chosen for these vital components primarily because of the savings in machining costs. Only a finish grinding operation is required. Consideration had been given to two other competitive processes. Forgings were ruled out because the initial tooling costs for the necessary quantities were too high. It was found that to machine these parts from bar steel would be too expensive.

The clutch pawl weighs 0.43 lb and measures approximately 2 in. long by 1½ in. max dia. A component ideally suited for precision casting, its intricate structure would otherwise require an assembly of several fabricated parts with consequent greater cost. In addition, this pawl has to have a tough core as well as a hard surface in order to withstand severe stresses when engaging the clutch. It is hardened to 55 to 60 Rockwell C and requires several grinding operations after casting.

The front twister anvil is a flat casting weighing 0.1 lb and measuring approximately 5/16 in. thick by 2 in. long by 1½ in. wide. There are two cored holes. The function of this component is to guide the bale wire into the knotter, and it is case hardened to 58 to 62 Rockwell C to prevent wear from the bale wire sliding over it.

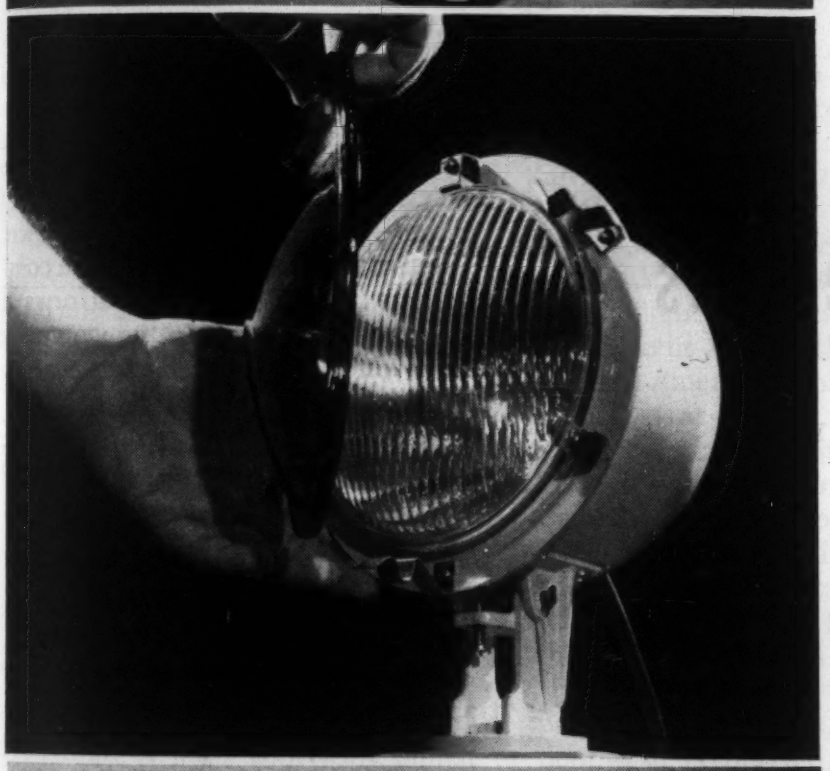
The rear twister anvil is also a flat casting weighing 0.125 lb and measuring approximately 5/16 in. thick by 2 in. long by 1¼ in. wide, with two cored holes. The function of this component is to feed the bale wire into the knotter and then shear it. The part is case hardened to 58 to 62 Rockwell C so that it will withstand wear from shearing the wire as well as wear from the wire sliding over it. Although the surface tolerance on the casting is held to plus or minus 0.0025 in., a grinding operation is necessary on the two flat surfaces because of the over-all plus or minus 0.001-in. tolerance requirement.

Front Twisting Anvil



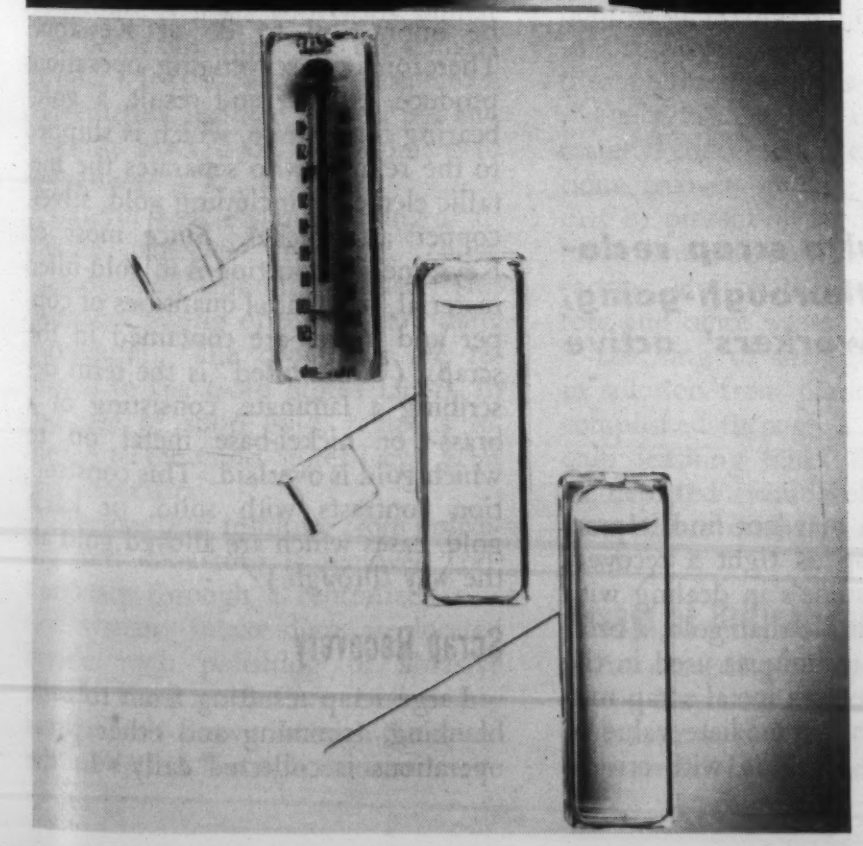
MOLDED PHENOLIC RECORD PLAYER The styling of the molded plastic case catches the eye on RCA's latest 45 record player. The case is made of a sturdy, deep maroon Durez phenolic, with grilled front. A handle is attached to the back of the case for convenience in moving the player from room to room. The smooth finish on the molded parts is extremely resistant to wear. The bottom, case and cover are all molded separately by The General Industries Co., but quickly and inexpensively assembled by using holes molded in the parts.

The player will use 12 records automatically. No posts or clamps have to be adjusted. All changes are made from the large center spindle. High quality workmanship in the player arm helps eliminate pressure on the records and cut wear. Fewer moving parts assure continuing trouble-free performance.

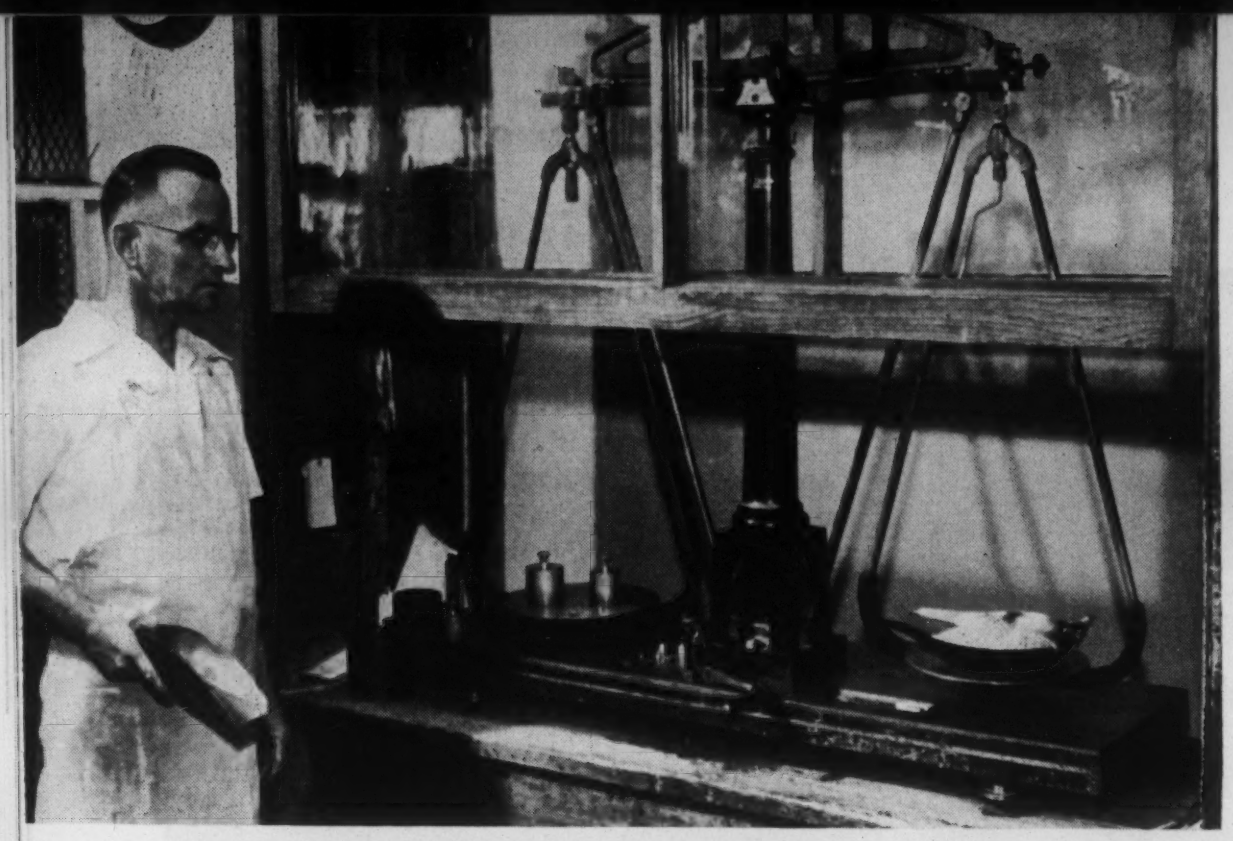


ALUMINUM AIRPORT LIGHTING UNIT A great simplification has been achieved by the Westinghouse Electric Corp. in the lighting fixture used with the accepted systems for marking the approach to an airport runway. The new unit consists of a deep-drawn aluminum shell with a holder for a standard 250- or 400-watt reflector-type airport lamp. Yet each fixture uses a color screen rated at only 100 watts (*i.e.*, it can stand the heat of a 100-watt lamp when enclosed with it).

This use of a low-cost screen was made possible by the direct expedient of extending it by clips about an inch from the edge of the housing—allowing air to circulate on the lamp side as well as the outside. A lamp can be changed in a matter of seconds, without tools. The whole thing weighs only 2½ lb, so that the supporting framework can be very light, even of wood if desired.



HEAT TREATED POLYSTYRENE CLIP A plastic automobile thermometer to be clipped to the outside of an automobile ventilator wing presented a new problem in molding polystyrene to Continental Can Co.'s Plastics Div.—and resulted in a brand new process. Requiring a high degree of strength in order to stand up under unusual stress and abuse, the clip for the thermometer was molded as a part of the thermometer-housing. In order to strengthen the clip, Continental engineers discovered a new method of heat treatment. They found that by subjecting the molded part of polystyrene to a certain degree of intensive heat, all molding strain departed, giving a stronger, more flexible part than the original mold. Now manufacturing these parts for the Chaney Manufacturing Co. of Springfield, Ohio, Continental uses its new method which involves placing the part as it comes out of the mold between a fixture composed of two heating elements. As soon as the material softens, the reinforced clip immediately is formed. To date, 100,000 pieces have been molded.



The Gold Stores Dept. is the nerve center of all Keystone's scrap claiming activities. Here each order is weighed in and out of each operation.

Press operations produce largest chunks of gold-bearing scrap.

Gold Scrap Recovery Methods Applicable to Scarce and Costly Materials

by BERNARD BLACKMAN, Superintendent,

and CARL HEINZMAN, Industrial Engineer,

Keystone Watch Case Div., The Riverside Metal Co.

Experience shows that to be successful a scrap reclamation program must be simple but thorough-going, easy to administer, and have the workers' active cooperation.

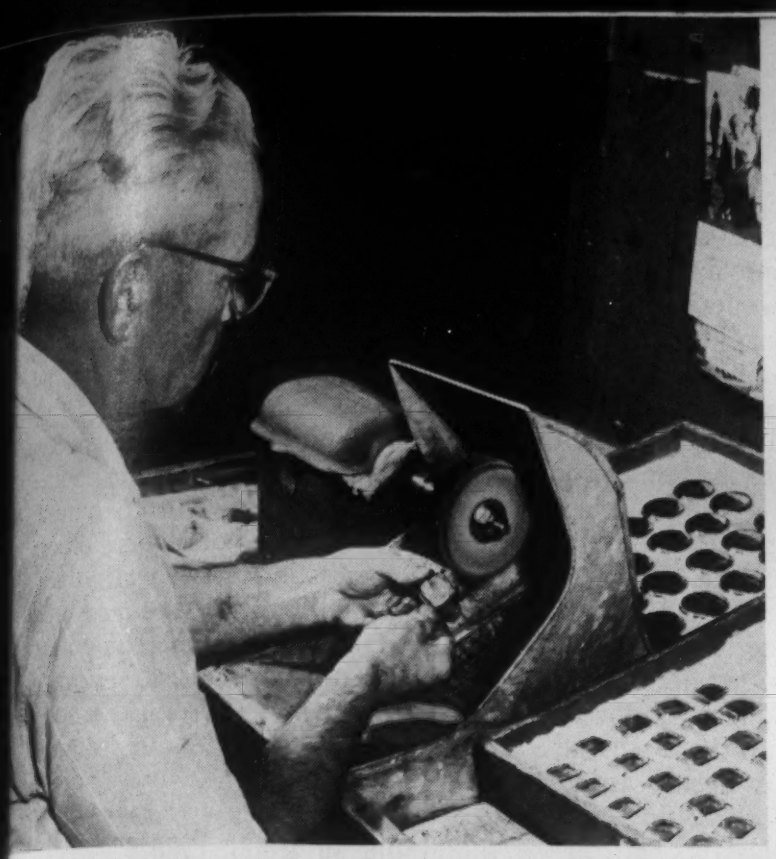
● SCAVENGING AND RECLAIMING precious metal scrap resulting from the manufacture of a varied line of solid gold and gold-filled cases are problems that the Keystone Watch Case Div. of The Riverside Metal Co. has lived with for nearly one hundred years. While other engineers and operating men may not find it practical to develop as tight a recovery system as Keystone's in dealing with metals less valuable than gold, a brief review of the techniques used in the recovery of precious metal scrap may be of direct and immediate value to those who are working with critical or costly materials.

There is nothing particularly complicated or revolutionary about the Keystone precious metals recovery system. The keynote is vigilance. Constant care at each step of the comparatively simple and straightforward recovery system saves the company many thousands of dollars each year.

Since nearly all of the scrap resulting from Keystone manufacturing operations contains many elements alloyed with the gold, the scavenging techniques are aimed mainly at physical collection and consolidation of all scrap that might have recovery value for the gold contained in it. Actual separation of the elements of an alloy, and the removal of impurities, are tricky refining jobs that would be impractical to do at Keystone. Therefore, all scavenging operations produce, as their end result, a gold-bearing concentrate, which is shipped to the refiner, who separates the metallic elements, including gold, silver, copper and nickel. Since most of Keystone's production is in gold-filled material, substantial quantities of copper and nickel are contained in the scrap. ("Gold-filled" is the term describing a laminate, consisting of a brass- or nickel-base metal on to which gold is overlaid. This construction contrasts with solid, or karat gold, cases which are alloyed gold all the way through.)

Scrap Recovery

Large scrap resulting from rolling, blanking, trimming and other press operations is collected daily. In the



Buffing and polishing operations on gold watch cases produce gold dust which is inhaled into a dust-collector system.

Table and floor sweeps, as well as larger pieces of valuable scrap recovered from ball-mill processing, are melted and resulting brick sent to gold refiner.

case of karat gold parts, this is done after each operation. Scrap is returned to the Gold Stores Dept., which acts as a clearing house for all precious metal in process.

It is here that a scrupulously-followed routine of checks and balances is maintained over all gold in process. On receipt of a batch of scrap, careful notations are made as to order number, weight of good parts, spoiled parts (if any), stock-making scrap, and press-department scrap. The total weight thus returned must equal the weight of original stock issued against the given order. The scrap is assembled, usually in drums, since the pieces are large, and sent to the refiner at convenient intervals.

Scrap resulting from machining operations is dealt with with similar care, but is not shipped to the refinery in bulk. It is melted and cast into a conveniently handled bullion bar and carefully assayed before shipment to the refiner.

Careful assembly and tagging of all minute particles (turnings, chips, shavings and trimmings) that result from machining operations are daily procedures. The containers are returned to the Gold Stores Dept. In the case of solid gold, scrap is returned to the Gold Stores Dept. after each operation.

Precious dust resulting from polishing and deburring is removed continuously through a centralized suction system. Intake ducts are located beside each polishing or abrasive wheel. Particles that are removed are immediately drawn through the opening, collected through a main intake line, and drawn into a filter press. The filter elements are checked continuously and the entire unit periodically broken down. Accumulated material is removed, concentrated, bagged, and sent to the refiner.

Laundering of all smocks, aprons, work clothes, gloves, towels and wiper cloths used in the manufacturing departments is done weekly in a special plant laundry. Waste water from the laundry is consolidated through a central drain, which carries it to a special reservoir in the plant Sweep House for admixing with alum and lime (to precipitate soap in the solution) prior to being pumped through a filter press.

Wash water from all plant wash basins and wash tubs, as well as all floor wash, is collected in the reservoir in the Sweep House and is driven through the filter press.

Daily burning of all combustible material concerned in everyday operations recovers minute particles that may be present on used emery cloths, buffs, brushes, polishing rags, paper cartons, and on the contents of factory and office waste baskets.

Leaching of any gold remaining in solution from plating baths is accomplished through a series of zinc-chip leaching tanks through which all depleted cyanide electrolyte must pass before discharge into the plant sewer.

Assays at Critical Points

An exceedingly important adjunct to the Keystone precious-metals control system is the 3-stage assaying of material in process. While these assays are not reclaiming techniques in themselves, they are essential controls over material from raw stock to finished product. It is through them that much of the specific information on all precious metal in process is obtained.

All outgoing water from watch cleaning baths, wash basins and laundry is mixed with alum and lime and pumped through filter presses. Engineer is holding chunk of cake removed from press.

Raw gold received from the supplier arrives marked with its exact weight to the nearest 1/1000th oz. Keystone accepts this weight, but immediately upon alloying, a dip-sample is taken. This is done for each lot melted. When the bar has been cast for rolling into gold-filled or karat gold stock, drill samples are taken and assayed to determine that the content is to required specification.

During fabrication of watch cases, assays are run at two stages—namely, at the "To Stores" stage, and at the "Completed Case" stage. These assays are made at least once a month on designs that are standard and are in continuous production. They are also made each time a new model is produced, each time a change is made in a stock layout, and immediately upon noticing any evidence that the given lot varies from standard.

The first assay is conducted after blanking and forming, but before cases are fitted, assembled and polished. It involves removal of two complete cases (back, bezel, center) from a production lot; assays made on one case must check with assays made on its mate.

The second assay conducted during manufacture is at the completed case stage, and is done to ascertain that precious metal content of watch cases to be shipped is up to standard. Variations beyond a specified tolerance result in a second assay. If the second assay still indicates off-standard production, the lat is rejected. It can readily be seen that below-standard gold content would be unacceptable to the customer; above-standard cases, conversely, would mean unnecessary loss to Keystone.

As a final check on the value of scrap shipped to the refiner in the form of bullion bars, drill samples are taken on each outgoing bar. A sample is taken at each end and in the center of the bar. These samples are then analyzed. The values are recorded and later checked against assays made at the refinery. It should be noted that the assay run on outgoing bullion bars produces an important value in the final check-and-balance, which measures the overall effectiveness of Keystone gold reclaiming procedures.

Sweep House Operation

It is to the Sweep House that all gold-bearing waste other than press department scrap and machining scrap is directed. Here the worthless material is removed and a finer concentrate produced.

Wash water from all drains in the Keystone plant (including the laundry) is accumulated in a special pit, where it is mixed with alum and lime to precipitate soap contained in the water. From the pit, the gold-laden solution is pumped through one of two filter presses. The filter presses are opened every week, the cake removed and charged into a special gas-fired furnace. Gold contained in ash resulting from the burning operation is then charged into a ball mill. The resulting discharge is sieved and the fines analyzed and tagged, then bagged and shipped to the refiner for recovery of gold.

The coarse discharge is run through the ball mill a second time, and again the resulting fines are bagged, tagged and sent to the refiner. The coarse remainder from this second pass is run through a magnetic separator to remove tramp iron and the discharge is sent to the precious metal casting shop at Keystone for melting and casting into a bar. Since this bar contains numerous ingredients, including dirt and several non-ferrous metals, there is no attempt to refine the bullion at Keystone. As previously noted, the casting operation is merely to put the coarser waste matter into a more convenient form for shipment to the refiner.

Iron particles which are removed by the magnetic separator are saved, since minute quantities of gold adhere to them. This material, which accumulates slowly, is collected in a special barrel which is shipped to the refiner about once a year for recovery of the precious metal content.

Table and floor sweepings accumulated as the result of press and machine operations are handled in much the same manner as the cake that is removed from the filter press. All material is charged into the gas furnace, the resulting ash being removed to the ball mill for two successive passes in order to separate coarse and fine concentrates. As a final step, the floor of the Sweep House itself is periodically cleaned, the material thus obtained being charged into the furnace and ball mill successively for recovering of any precious metal.

Some Loss Inevitable

It is characteristic of watch case manufacturers that a very large percentage of the raw material entering the plant develops into scrap in one form or another. It has been estimated that of the gold-filled stock entering the press room for the first operation, only about 44% actually finds its way into a finished watch case. The remaining 56% is scrap. Of course, by far the largest portion of this scrap is reclaimed immediately after blanking and trimming operations. However, the difference between profit and loss on the manufacture as a whole is determined by the percentage of less easily reclaimed scrap which is eventually turned into a credit for the Keystone account by the refiner.

A certain amount of scrap is necessarily lost and irrecoverable. Some particles find their way into minute cracks and crevices of floors; others into interstices in furnace walls, flues, etc., none of which could be recovered without tearing down the equipment itself. Keystone engineers estimate this loss to be in the neighborhood of 0.4 to 0.5 oz per hundred ounces of original gold.

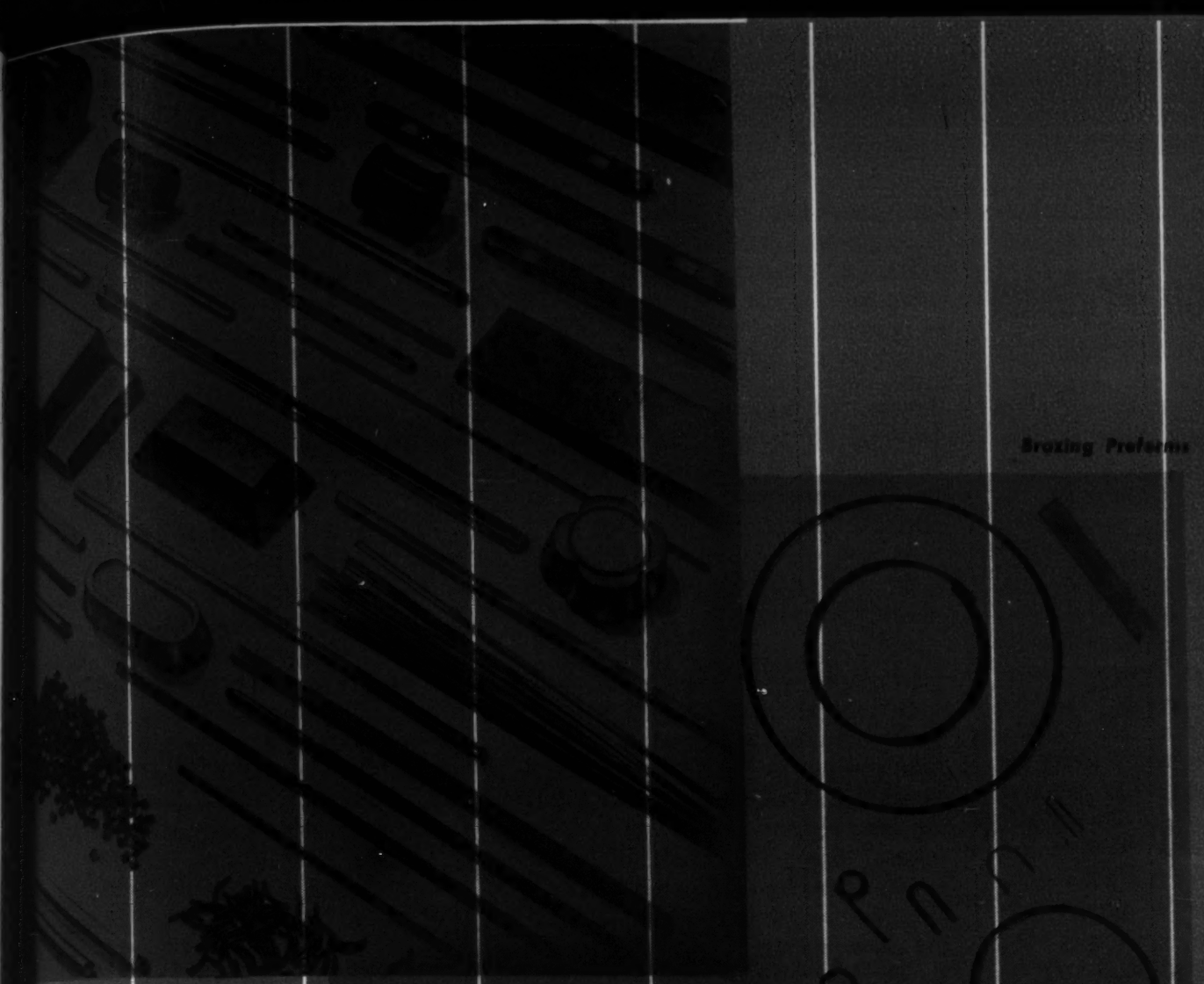
Adaptable to Other Plants

The system used at Keystone in the recovery of precious metal scrap could be adapted, with revisions, to any manufacturing process, since it is directed to the physical assembly and concentration of valuable particles at certain designated stages of production.

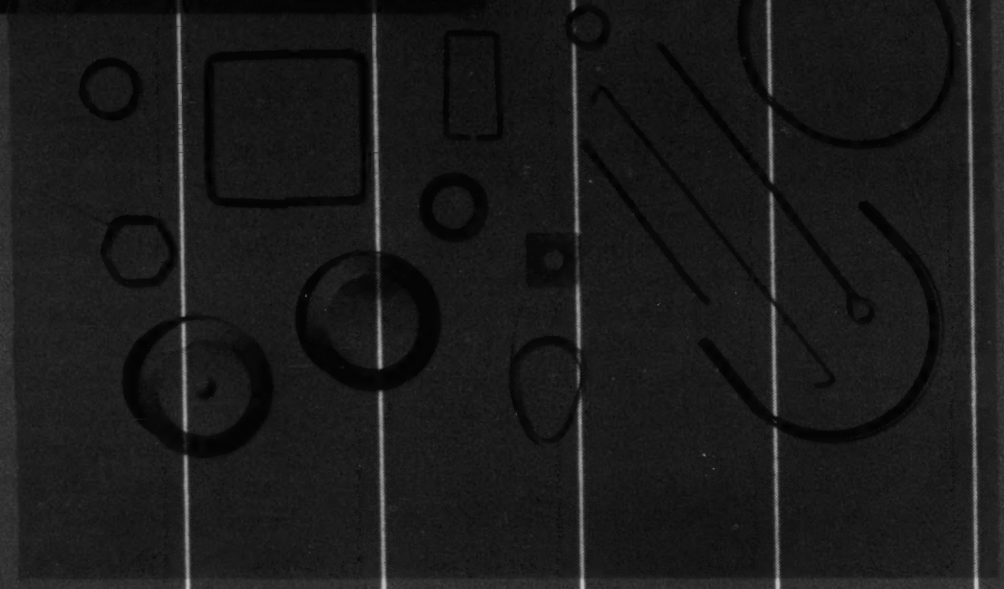
With the possible exception of certain assay procedures and the leaching of cyanide electrolyte (both steps particularly adapted to gold recovery), the scavenging techniques referred to here can be used in the recovery of any valuable solid matter.

It can be appreciated that any program for the recovery of values from scrap can be fully effective only when constantly checked to determine its efficiency. At Keystone, a continuous check-and-balance of all material in process is maintained. All points of loss are thus identified and points of severest loss focused on for extra attention and study. Frequent checks mean that any abnormal loss is noted almost immediately. Lastly, the entire program is periodically examined with a view to simplifying it.

In closing, it should be emphasized that no techniques for the recovery of valuable scrap should become so complex and difficult to maintain that they defeat their own purpose. A simple, easy-to-follow program will not only be easier to administer, but it will also enlist workers' cooperation. The active interest and cooperation of all plant personnel concerned are vital to any recovery program. Generally speaking, the simpler the system is the easier it is to maintain, and as a direct consequence, the more constant will be the cooperation of the workmen on the job, on whom, in the last analysis, the success of the recovery program depends.



Brazing Preforms



Solder Forms

How to Select

Brazing and Soldering Materials

MATERIALS & METHODS MANUAL No. 80

This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

MARCH 1952

by H. R. Clauser, Managing Editor, Materials & Methods

Selecting the proper brazing alloy or soft solder, and the proper flux is an important and difficult job. The purpose of this Manual is to aid in solving this selection problem by presenting a broad view of the types, characteristics and uses of the available brazing and soldering materials. It covers:

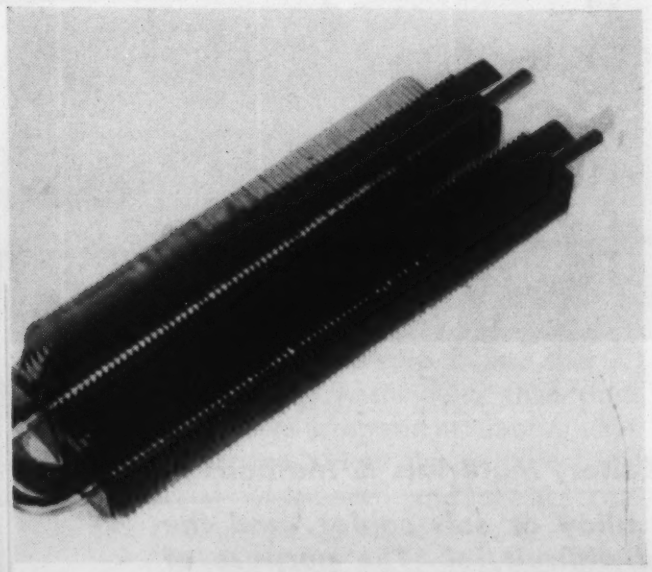
- ***The Selection Problem***
- ***Brazing Alloys and Fluxes***
- ***Soft Solders and Fluxes***
- ***Brazing Alloys and Solders for Various Metals***

The Selection Problem

One of the fundamental and most important factors that must be considered in order to make satisfactory brazed and soldered joints is the selection of the filler metals and fluxes. Choosing the proper brazing and soldering materials is not an easy job, for many controlling factors must be considered and there are hundreds of proprietary products from which to choose.

The main purpose of this manual, therefore, is to serve as a guide to the selection of proper brazing and soldering materials from among the many available. Obviously it cannot give all the information needed to make final selections for specific applications. But it can help by giving a broad view of types and characteristics of brazing alloys, solders and fluxes that are widely used and that are generally considered standard. For more specific help the various suppliers of these materials should be consulted.

There are a number of specifications on brazing and soldering materials that can also be consulted for exact composition and performance requirements. The more important ones are published by the Society of Automotive Engineers, American Society for Testing Materials, and the Federal Government and Armed Forces. At present, a comprehensive brazing filler metal specification is being prepared by a joint committee of the American Welding Society and the Society for Testing Materials, and when published should do much to standardize the most commonly used alloys.



To fabricate this heat transfer unit, a tubing with a thin layer of silver solder clad to outside was used. Fins were assembled and when unit passed through a controlled atmosphere furnace, the brazing alloy from tube flowed into joint. (General Plate Div.)

What Is Brazing and Soldering

Brazing and soldering is generally understood to mean the joining of two metals by means of another metal or alloy which melts below the temperature of the metals being joined. The principal distinction between a brazed or soldered joint and a welded joint is that, in welding, the base metals are heated to or above their melting point, which is not the case in brazing and soldering.

Brazing is defined by the American Welding Society as "a group of welding processes wherein coalescence is produced by heating to suitable temperatures above 800 F and by using a nonferrous filler metal having a melting point below that of the base metals. The filler metal is distributed between closely fitted surfaces of the joint by capillary attraction."

It should be noted that this definition does not include the process commonly called braze welding in which the method of filler metal deposition is more closely related to oxyacetylene welding. Therefore, filler metals for this process will not be specifically covered, although in some cases they are of the same composition as the brazing material.

Solders are nonferrous metals and alloys melting below 800 F which are used to join the common metals. They are often termed soft solders to distinguish them from brazing alloys, which are sometimes called hard solders.

Requirements of Brazing Alloys and Solders

One of the basic requirements of brazing and soldering filler metals is that they melt and flow freely at a temperature lower than the melting temperature of the metals being joined. In general, it is preferable to have a reasonable difference between the melting point of the filler metal and base metal to allow for inaccuracies in temperature control. Temperature differentials of about 200 F are preferable. However, where temperatures can be closely controlled, differentials of as little as 50 F are successful.

Except for pure metals and certain eutectic compositions, brazing and soldering alloys have a *melting range* which has as its lower limit the temperature at which the alloy begins to melt, called the *melting point* or *solidus* temperature, and as its upper limit the temperature at which the alloy is completely liquid, called the *flow point* or *liquidus* temperature. Between the melting point and the flow point the alloy is in a plastic condition; part of the metal is solid and part is liquid. This melting range is an important consideration, for parts being joined cannot be moved while the joint is cooling through this range. In general, therefore, the shortest possible melting range is usually preferred.

Another requirement is that the molten filler metal wet and adhere to the surfaces to be joined. The subject of wetting action and adhesion is too complex to go into here. In general, it can be said that most satisfactory adhesion is obtained when the filler metal, or one of its constituents, alloys with the metal or metals being joined. And the degree of surface alloying depends largely on maintaining a clean surface during the brazing or soldering operation. Cleanliness of the surface, in turn, depends on the use of proper fluxes.

Other metallurgical requirements of brazing and soldering filler metals are: they must not oxidize or volatilize too freely; they must not diffuse too freely into the base metal at brazing temperatures nor dissolve too much of the metals being joined.

Besides these basic metallurgical considerations, brazing alloys and solders should be capable of producing joints of sufficient strength, toughness, soundness and permanence to meet the performance requirements. Strength requirements are of particular importance. In general, soldered joints cannot be used where stressed parts are in-

volved. Brazed joints, however, are suitable for joints subjected to a moderate amount of stress. Usually, shear strengths of the brazed joints rather than strength of the filler metal itself is the important consideration in selecting filler metals. The joint strength depends upon a number of factors, including strength of the members being joined, thickness of filler metal layer, or "clearance," and type of joint and other design considerations.

Brazing alloys and solders selected to meet requirements of specific applications must also often have special attributes, such as electrical and heat conductivity, certain color, and resistance to weathering or chemical attack. Where corrosion resistance is a factor and where dissimilar metals are being joined, it must be remembered that the corrosion resistance of a combination of different metals can be considerably different from the corrosion resistance of the metals by themselves.

An important consideration in selecting brazing and soldering materials is the forms in which they are commercially available. Both solders and brazing alloys are available in standard forms such as rod and wire. A number of the alloys can also be obtained as shims, rings, inserts, flushed or laminated strip and other preforms to meet specific requirements. However, certain compositions are not too ductile and, therefore, are limited in the shapes and sizes that can be formed.

Finally, the soldering or brazing method to be used influences the choice of the filler metal. Accompanying illustrations show the major processes used which are: torch, furnace, induction, resistance, dip, and twin arc. Each of these processes involves a different method and speed of applying heat to the joint and, therefore, certain filler metals will not perform satisfactorily with all the processes.

Brazing Alloys and Fluxes

Filler metals used in brazing are commonly referred to as brazing alloys. They are also often called hard solders and are distinguished from the soft solders by their higher melting points, which is always above 800 F, and by the higher joint strengths they provide.

The two most commonly used groups of brazing alloys are: (1) the silver alloys, and (2) the copper and copper alloys. There are also several alloys for brazing heat resistant materials, a number of copper-gold alloys, aluminum-silicon alloys for aluminum, and a magnesium brazing alloy. Falling into each of the main groups of brazing alloys are many special brazing materials for applications where certain special requirements must be met, such as high remelt temperatures, high strength, extra good wettability, etc. These are usually proprietary products and so the suppliers should be contacted for advice on meeting special brazing problems. In this manual only the common standard alloys will be covered.

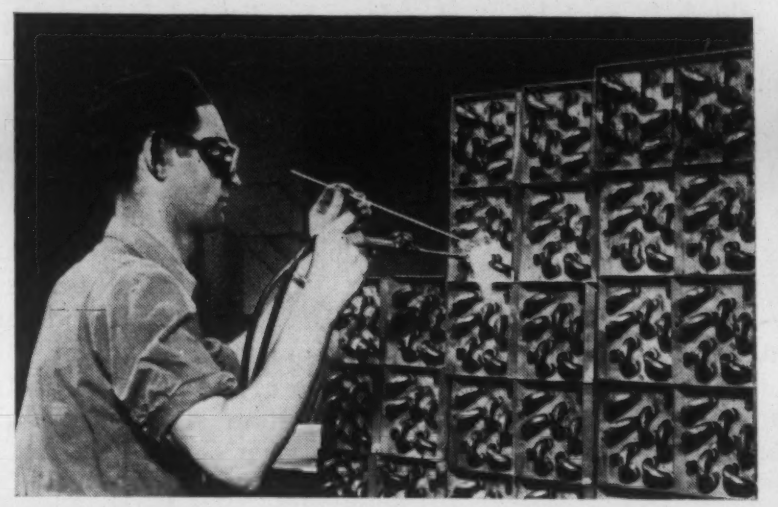
Silver Brazing Alloys

Silver brazing alloys are principally alloys of silver, copper and zinc having melting points ranging from about 1100 to 1600 F. Other elements, such as tin, nickel and cadmium, are sometimes added either singly or in combination to obtain special properties. The silver serves to lower the melting point, provide corrosion resistance, and

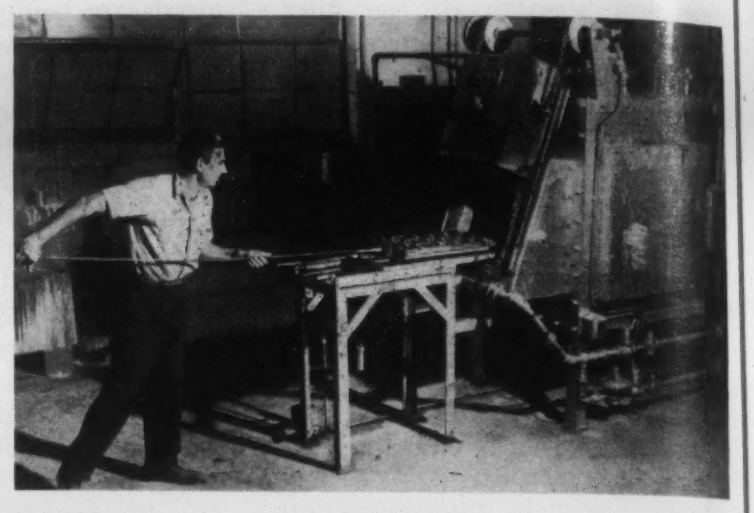
Table 1—Typical Silver Brazing Alloys

Composition, %				Solidus, F	Liquidus, F	Brazing Range, F	Color	Standard Forms	Size, In.
Ag	Cu	Zn	Others						
44–46	14–16	14–18	Cd, 23–25	1125	1145	1145–1400	Yellow	Sheet and strip	0.003 to 0.025
34–36	25–27	19–23	Cd, 17–19	1125	1295	1295–1550	Yellow		
49–51	14.5–16.5	13.5–17.5	Cd, 15–17 Ni, 2.5–3.5	1195	1270	1270–1500	Yellow		
39–41	29–31	26–30	Ni, 1.5–2.5	1240	1435	1435–1650	Yellow		
44–46	29–31	23–27	—	1250	1370	1370–1550	Nearly White	Wire in coils	Round, 0.016 to 3/16
49–51	33–35	14–18	—	1270	1425	1425–1600	Nearly White		Square, 1/8 to 3/16
55–57	21–23	15–19	Sn, 4.5–5.5	1145	1205	1205–1400	White	Rod	Round, 1/16 to 1/4 by 18 to 36
71–73	27–29	—	—	1435	1435	1435–1800	White		Square, 1/8 to 1/4 by 18 to 36
64–66	19–21	13–17	—	1280	1325	1325–1550	White	Powder	50 to 325 mesh
69–71	19–21	8–12	—	1335	1390	1390–1600	White		
74–76	21–23	2.5–3.5	—	1365	1450	1450–1650	White		

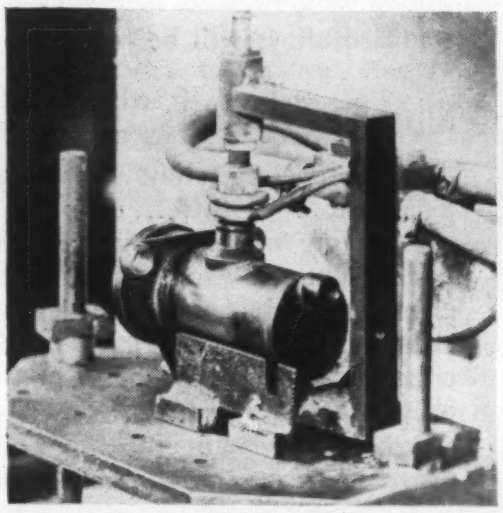
COMMON BRAZING METHODS



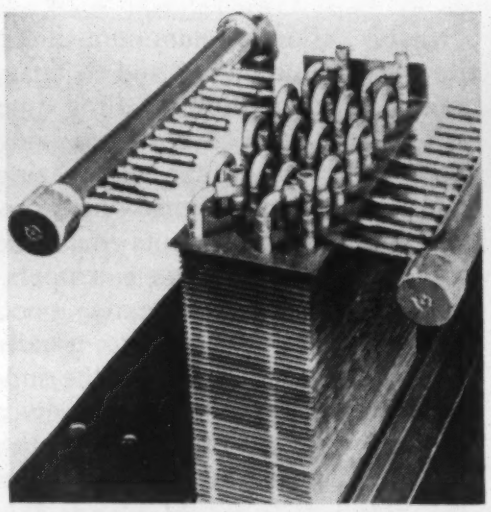
Gas Torches *provide the hottest flame and are widely used. They burn various types of fuel, including oxygen-acetylene, city or natural gas and oxygen, acetylene and air, city gas and air.*



Furnaces *are used for production brazing small or medium size assemblies. Brazing alloy is usually preplaced on parts and nonoxidizing atmosphere is commonly used.*

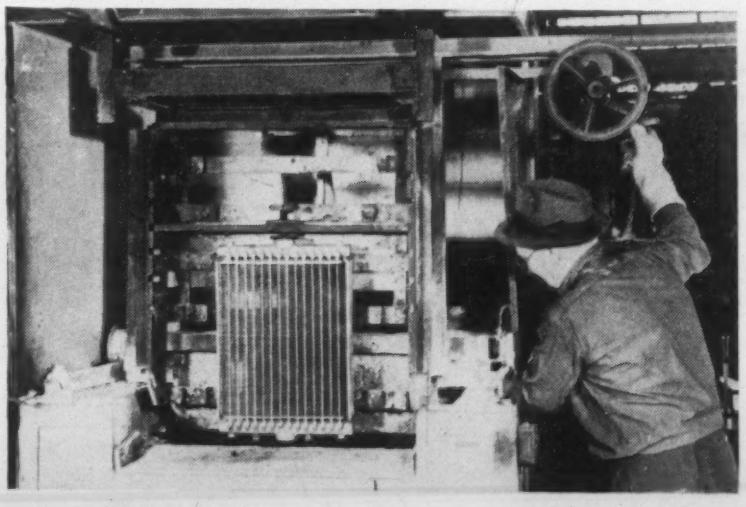


Induction *heating is fast and localized. Parts and brazing preforms are usually assembled in a fixture which positions them inside induction coil.*

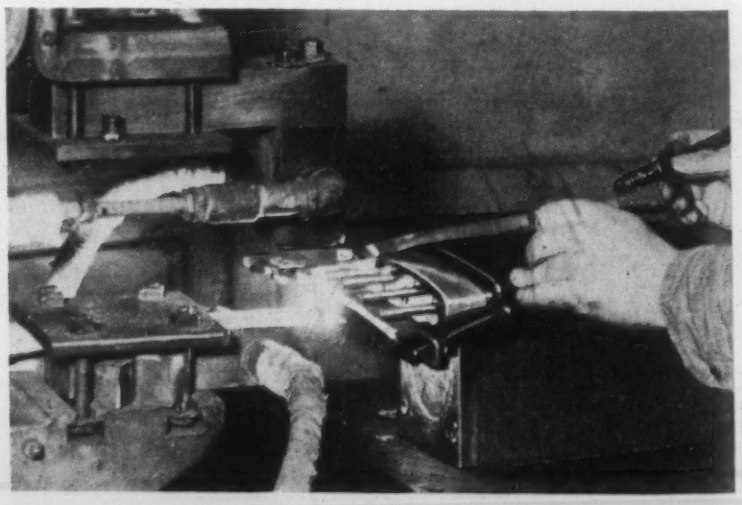


Gas-Air Burners *of various kinds, including a radiant heat type, are readily adapted to production brazing of regular or irregular parts.*

Electrical Resistance *method is well adapted for small lap joints and brazing relatively small size parts for electrical apparatus.*



Salt or Metal Dip *methods are suitable for both large and small parts and particularly for irregular shaped assemblies. The dipping is done in either a molten brazing alloy or a fused chemical salt.*



Incandescent Carbon *process is a fast heating method suitable for small parts. It places parts under pressure and heats them at same time.*

(Courtesy Handy & Harman)

make the brazed joint tough and ductile. Nickel when added improves wetting on certain metals, increases corrosion resistance against certain conditions, and modifies flow characteristics. Cadmium can be added to replace part of the zinc to give a combination of low melting and flow temperatures with minimum ductility loss. Tin provides lower melting and flow temperatures, and improves the wetting qualities of the silver-copper compositions. The cost of silver brazing alloys increases with the silver content. Therefore, an alloy containing just enough silver to give the desired properties should usually be selected.

A great variety of compositions are commercially available; however, less than 20 alloys have been found suitable for most purposes. Most of the alloys commonly used are given in Table 1. The eutectic composition has 72 silver and 28% copper, and its melting and flow points are the same (1435 F). All other compositions exhibit a range of temperatures through which melting occurs. The significance of the melting range in the selection of brazing alloys has been covered in an earlier section.

Most silver brazing alloys are available as: thin sheet, strip, fine wire, rod, burned or powdered forms, and preforms including rings, shims and washers. Solder flushed stock and clad or laminated strip and shapes are also available for applications where a layer of brazing alloy on one or two sides of a strip would be advantageous. In general, any silver brazing alloy can be clad on any common base metal and supplied as strip in conventional sizes. Solder-flushed wire and tubing is also available.

Silver brazing alloys are used on irons, steels and nonferrous metals except aluminum and magnesium. They can also be used to join a wide range of dissimilar metals and alloys as seen in Table 10. It should be noted that the general purpose brazing alloys are the terniary types containing from 30 to 60% silver, and copper and zinc. Silver alloys are used with all brazing methods. Lap or tee joints are recommended but scarf or butt joints can be used if requirements are less stringent.

Silver brazed joints vary in color from the yellowish brass-like color of the low silver content solders to the pinkish white of the low flowing types and to the silvery white of alloys having silver content above 60%.

The electrical conductivity of silver brazing alloys containing only silver and copper are relatively high. The eutectic composition has a conductivity of about 77% IACA, while the tin-rich and phosphorus compositions can be as low as 15% IACS. In general, average conductivity for the other alloys ranges from 20 to 27 IACS.

Strength Properties — The joint tensile strengths with most silver brazing alloys run around 50,000 to 60,000 psi. However, when metallurgical and mechanical considerations are favorable, joint tensile strengths above 100,000 psi have been obtained. Maximum bond strength is generally obtained with joint spacings of 0.001 to 0.005 in. Clearances above 0.005 in., in general, give diminishing strengths. Shear strengths based on brazed low carbon steel joints range from around 30,000 to 40,000 psi.

Since silver brazing alloys have low melting points, they weaken at lower temperatures than do the metals being joined. Generally, the short time tensile strength of the general purpose alloys is about one-half the room temperature strength when temperature is raised from 70 to 500 F. This applies to butt and shear joints in soft or hard steels.

In themselves, silver brazing alloys have relatively high impact strength. However, the impact strength of a brazed joint is largely effected by the strength of the materials being joined and design considerations; therefore, it is difficult to generalize. The fatigue strength of silver brazed joints is of the same order of magnitude as the materials being joined up to about 27,000 psi. Where materials stronger than this are involved, the higher fatigue strengths cannot be realized unless the design is such that the fatiguing stress in the brazing layer does not exceed the 27,000 psi figure.

Copper and Copper Alloy Brazing Metals

The brazing alloys in this group cover a wide spread of melting points ranging from about 1300 to around 2000 F. The lower melting point alloys are frequently termed brazing spelters. Table 2 lists a number of the common copper and brass brazing alloys. These brazing alloys can be used with all the different brazing processes. Lap, tee and butt joints, and clearances of from 0.002 to 0.005 in., are commonly used. They are useful for joining nearly all common ferrous and nonferrous alloys.

Little information is available on the joint properties of copper and copper alloy brazed joints. In general, however, it can be said that the shear strengths of copper brazed joints (in low carbon steel) are lower than those obtained with silver brazing alloys. The shear strengths range from around 20,000 to 30,000 psi. At present an investigation is under way, sponsored by the Copper and Brass Research Assn. to determine brazed joint strengths in copper plate and sheet using both copper and silver brazing alloys.

Copper — Pure copper is widely used for hydrogen brazing steel parts. It is very free flowing and makes a strong, ductile, sound joint that will withstand relatively high temperatures. Copper brazing is usually done in an atmosphere furnace, and if the proper reducing atmosphere is maintained no flux is needed for brazing low carbon and stainless steels. Pure copper brazing filler metal is available in strip, foil, sheet, wire, and finely divided form. It is also available as clad or laminated strip and shapes in combination with the common metals. Recently, copper brazing material in the form of a paste has been introduced. Iron is present in several formulations and serves to decrease fluidity of the molten copper and increases joint strength. Flux is also included in some of the formulations.

Copper-Zinc — The brass brazing alloys are composed of varying proportions of copper and zinc with or without small amounts of tin and nickel. Those having about 40% zinc melt and flow at lower temperatures than copper. They are malleable and ductile enough to be produced in wrought forms and make strong, tough joints. The alloys containing around 50% zinc have still lower melting points, but are brittle and only available in lump and grain form. Therefore, these alloys must usually be applied in powder form or by dip brazing methods. The granulated forms are available in several different colors, such as yellow, gray or black, as well as in different shapes and sizes of

Table 2—Copper, Copper-Zinc and Copper Phosphorus Brazing Alloys

Nominal Composition, %			Solidus, F	Liquidus, F	Brazing Range, F	Standard Forms	Size, In.
Cu	Zn	Others					
99.9	—	—	1950	1980	2000–2100	Sheet and strip	0.004 to 0.025
58–62	42–38	—	1650	1660	1670–1750	Wire in coils	Round, 0.003 to ¼
57	42	Sn, 1.0	1630	1650	1670–1750		
56	Rem.	Sn, 1.0 Mn, 1.0 Ni, 1.0	1590	1630	1670–1750	Rod	Round, 1/16 to 3/8
52–55	48–45	—	1570	1595	1600–1700	Grain	—
50–53	Rem.	Sn, 4.5–5.5	1585	1610	1620–1700	Grain	—
46–50	Rem.	Ni, 9–11	1690	1715	1720–1800	Wire in coils Rod	Round, 1/16 to ¼ Round, 1/32 to ¼ by 18 to 36
46–48	Rem.	Ni, 10–11 Ag, 0.30–1.0	1685	1710	1700–1800	Wire in coils Rod Powder	Round, 1/16 to ¼ Round, 1/16 to ¼ by 18 to 36 40 to 180 mesh
P	Ag	Cu					
4.75–5.25	—	Rem.	1305	1650	1450–1650	Strip Wire in coils	0.005 to 0.015 by 1½ Round, 1/16 to 3/16
6.75–7.50	—	Rem.	1305	1485	1350–1485	Rod Powder	Square, 1/8 to 3/16 Round, 1/16 to ¼ by 18 to 36 Square, 1/8 to ¼ by 18 to 36 50 to 325 mesh
6.00–6.50	4.75–5.25	Rem.	1195	1500	1300–1500	Wire in coils Rod Powder	Round, 0.047 to 1/8 Round, 1/16 to ¼ by 18 to 36 50 to 325 mesh
6.75–7.50	5.75–6.25	Rem.	1185	1380	1290–1380	Wire in coils Rods Powder	Round, 0.047 to 3/16 Square, 1/8 to ¼ by 18 to 36 Round, 1/16 to ¼ by 18 to 36 Square, 1/8 to ¼ by 18 to 36 50 to 325 mesh
4.75–5.25	14.50–15.50	Rem.	1185	1500	1300–1495	Sheet and strip Wire in coils Rods Powder	0.003 to 0.025 Round, 0.010 to ¼ Square, 1/8 to ¼ Round, 1/32 to ¼ by 18 to 36 Square, 1/8 to ¼ by 18 to 36 50 to 325 mesh

particles. The brass brazing alloys require the use of flux because zinc oxidizes in any but the driest, oxygen - free atmosphere. When using brass filler metals, overheating must be guarded against since voids may be formed in the joint by entrapped zinc vapors.

Copper - Phosphorus — Copper-phosphorus alloys containing from 4.0 to 8.0% phosphorus are used principally for joining copper and copper alloys. They should not be used on irons and steels. The eutectic composition (91.7 copper, 8.3% phosphorus) is brittle, but those alloys near this composition are available in sheet, rod and wire forms. Other alloys of this type contain from about 5 to 7% phosphorus and from about 5 to 15% silver. These alloys are self fluxing with copper, but not when used on other metals or alloys. As filler metals on copper, they have excellent electrical and thermal conductivity. They are not recommended for use in sulfurus atmospheres above room temperature. Copper-phosphorus alloys are suitable with all brazing methods. Lap and tee joints are generally used. They have a tendency to liquate if heated slowly. Therefore, heat should be applied as rapidly as possible, especially if the filler metal is preplaced.

Other Brazing Alloys

In addition to the principal brazing alloys just discussed, there are many others that have more narrow application. Aluminum-silicon alloys are available for brazing aluminum and certain aluminum alloys. They are covered later in the section devoted to aluminum. Also there are two magnesium brazing alloys which will be discussed later.

Copper-Gold — These alloys are primarily used for joining electron tube assemblies where gas inclusions are undesirable. The brazing is usually done without flux in reducing atmosphere or a vacuum. For other uses borax-boric acid flux is used. One common copper gold brazing alloy consists of about 63 copper and 37% gold; another has a composition of about 20 copper, 80% gold (see Table 3).

Heat Resistant Types — The most common heat resistant brazing alloys are given in Table 3. They include nickel-chromium, silver-manganese, nickel-manganese alloys and pure nickel. The nickel-chromium alloy is used chiefly for joining stainless steels and high nickel alloys that are subject to high temperatures. However, the alloy can also be used on carbon and low alloy steels. It retains its heat resistant properties up to about 2000 F, and also has excellent corrosion resistance. When brazing is done in a dry hydrogen atmosphere, no flux is required. Flux is used, however, when brazing in standard atmosphere furnaces.

The silver-manganese alloy, a German development, is also used chiefly on stainless steel and high nickel alloys. It does not have as good high temperature properties as the nickel-chromium alloy, but possesses good strength in the 500 to 900 F range.

The nickel-manganese compositions are not as widely used as the previous two, but are suitable for high temperature, high strength applications on some stainless steels. Nickel is used for brazing such metals as tungsten and molybdenum for high temperature service.

Brazing Fluxes

Choice of the proper brazing flux in reference to the brazing alloy and base metals being joined is extremely important. The functions of fluxes are: (1) to minimize oxidation of the filler metal and surfaces of the material being joined during the brazing operation; (2) to dissolve any oxides which may have formed before brazing or during the heating; (3) to promote the free flowing of the filler metal. Selection of the proper flux depends on both the brazing alloy and metals being joined, and also on the fact that the flux must be fluid and chemically active at the brazing temperature.

There are a great variety of proprietary fluxes on the market, but most of them fall into one of the three broad groups described below.

High Temperature Fluxes — The fluxes in this group are formulated for use with copper and brass brazing alloys at temperatures down to about 1500 F. The essential ingredients are borax and boric acid. Proprietary formulations have various combinations of these basic ingredients and may or may not have additional chemicals to provide special characteristics.

General Purpose Low Temperature Fluxes—This group includes the fluxes which melt at temperatures below around 1500 and which are used with silver brazing alloys and copper-phosphorus alloys. Borax, or mixtures of borax and boric acid, constitute most of the fluxes in this group melting around 1400 F. Many proprietary fluxes of the borax-boric acid types are available. Some contain phosphorus and halogen salt additions. For brazing temperatures less than 1400 F, general purpose fluxes containing fluorides and alkali salts, preferably postassium, are generally applicable. They are used extensively with silver brazing alloys.

Special Purpose Fluxes—There are a great many special purpose fluxes, and only a few important types can be mentioned. A special fluoride type flux containing one or more chlorides of sodium, potassium, zinc or lithium is needed for brazing high aluminum bronzes to each other or to steel. Special fluxes are also required for silver alloys with brazing temperatures above around 1600 F, for brazing the refractory alloys, molybdenum and tungsten, and for applications involving long heating cycles under oxidizing conditions.

Available Forms — Brazing fluxes are available in the form of powder, paste or solution, vapor gas, and coating on welding rod. The form to use depends on the particular application. Powder flux can be spread on the joint prior to heating, or if the brazing alloy is used in a finely divided form, the flux can be mixed with it. Paste flux is a convenient form; when applicable, a thin, even coat can be rapidly applied by brush. The vapor or gas flux form is used in conjunction with torch brazing. It is applicable in brazing with bronze rod or silver brazing alloys. The flux is applied to the work through the oxyacetylene flame. This is accomplished by passing the acetylene through a flux solution; the gas picks up small amounts of the flux, which melts in the flame and is deposited at the joint in that form.

Flux coated rods are confined to the copper brazing alloys, and to high zinc bronze compositions in particular. With them, it is still necessary to flux the surface of the materials being joined in order to eliminate the oxides that may form during heating.

Table 3—High Temperature Service and Copper-Gold Brazing Alloys

Name	Nominal Composition, %	Solidus, F	Liquidus, F	Brazing Range, F	Remarks
Nickel-Chromium	Nickel, 65–75 Chromium, 13–20 Boron, 2.75–4.75 Fe + Si + C, 10 max	1850	1950	2000–2150	High temperature alloy. Chiefly for stainless steels and high nickel alloys.
Silver-Manganese	Silver, 84–86 Manganese, 14–16	1760	1780	1780–2100	
Nickel-Manganese	Nickel, 80 Manganese, 20	—	2327	—	High temperature alloy. Chiefly for stainless steels.
Nickel	Nickel, 100	—	2644	—	Used for such metals as tungsten and molybdenum, for high temperature use.
Copper-Gold	Gold, 37.25–37.75 Copper, Rem.	1755	1815	1815–2000	Used chiefly for joining parts in electron tube assemblies.
Copper-Gold	Gold, 79.75–80.25 Copper, Rem.	1620	1630	1630–1850	

Fluxes used with aluminum and magnesium brazing alloys are covered in the section devoted to brazing these metals. Also, more detail on fluxes to use in brazing specific materials is given under the sections devoted to each material.

In furnace brazing, flux is usually not required if a reducing atmosphere is used to prevent formation of oxide film on the brazing alloy and the base metal. Lean cracked city gas is commonly used. However, more expensive atmospheres, such as dissociated anhydrous ammonia, permits more versatility in choice of brazing alloy and metals that can be joined.

In silver brazing, some of the alloys have a greater tendency to oxidize in moist protective atmospheres. Those containing a high percentage of zinc, for example, will not remain bright or flow properly in regular cracked city gas atmospheres of more than 70 F dew point at the correct cracking temperature.

Soft Solders and Fluxes

The principal distinguishing characteristic about soft solders is that they all have melting points below 800 F and generally not higher than 600 F. They can withstand considerable bending without fracture, but have low strength compared to that of the materials usually joined. Therefore, soft solders are primarily used for fastening together nonstressed parts and for sealing purposes.

The most widely used soft solders are those composed of tin and lead with or without other minor alloying elements. Other types include lead-silver, silver-tin-lead, bismuth-lead-tin, indium bearing, and aluminum solders.

The commercial soft solders are available in a number of forms and preforms. They are produced as bar, wire, strip, foil, ribbon, rings, washers, disks, pellets and powder. Slab and ingot forms are available for large soldering operations using melting kettles or tanks. Wire solder is also made with a flux core. The powder form is also obtainable mixed with either powdered or paste flux.

Lead-Tin Solders

In general, almost any tin-lead composition is capable of bonding with the common metals. However, only a relatively small number of the possible combinations are actually in wide commercial use. Table 4 lists a number of the soft solders that are covered by current specifications and which are in most common use today.

The accompanying drawing shows the familiar tin-lead constitutional diagram. From it the following points can be observed: (1) The eutectic composition (62 tin, 38% lead) has a single melting temperature of 362 F. (2) All compositions containing between 20 and 97% tin also have a solidus temperature of 362 F, but the liquidus temperature varies with the lead and tin content. (3) Alloys containing up to about 20% tin have a solidus temperature varying from 362 to 621 F. (4) Alloys containing more than 97.5% tin have a solidus temperature varying from 362 to 450 F. (5) The alloy containing about 20

Table 4—Typical Soft Solders

Nominal Composition, %					Melting Range, F		Specifications		
Tin	Lead	Silver	Antimony	Others	Solidus	Liquidus	ASTM	SAE	Federal (QQ-S-5716)
70	30	—	0.12–0.50	—	362	380	70	—	Sn, 70
62	38	—	—	—	362	362	—	—	—
60	40	—	0.12–0.50	—	362	372	60	—	Sn, 60
50	50	—	0.12–0.50	—	362	417	50	—	Sn, 50
40	60	—	0.12–0.50	—	362	460	40	2A	Sn, 40
30	70	—	0.12–1.8	—	362	500	30	3A	Sn, 30
20	80	—	0.5 –1.2	—	362	525	20	5A	Sn, 20
15	85	—	0.5	—	362	550	15	6A	—
94	0.2	—	4–6	—	450	464	—	—	Sb, 5
0	97.5	2.5	—	—	590	590	2.5S	—	Ag, 2.5
1	97.5	1.5	—	—	589	589	1.5S	—	—
3	92	—	5	—	463	545	—	—	—
37.5	37.5	—	—	25 indium	274	358	—	—	—
—	—	5	—	95 cadmium	640	750	—	—	—
—	90	—	—	8 cadmium 2 zinc	410	530	—	—	—

COMMON SOLDERING METHODS

Heated Iron or Copper *method is the most common means of soldering. The copper point can be electrically heated, or be heated by a burner built into the iron, or externally by means of a furnace or torch. (American Meter Co.)*

Torch *soldering is one of the fastest methods applying heat. Various combinations, such as gas and air, gas and oxygen, oxygen and acetylene are used. (Studebaker Corp.)*

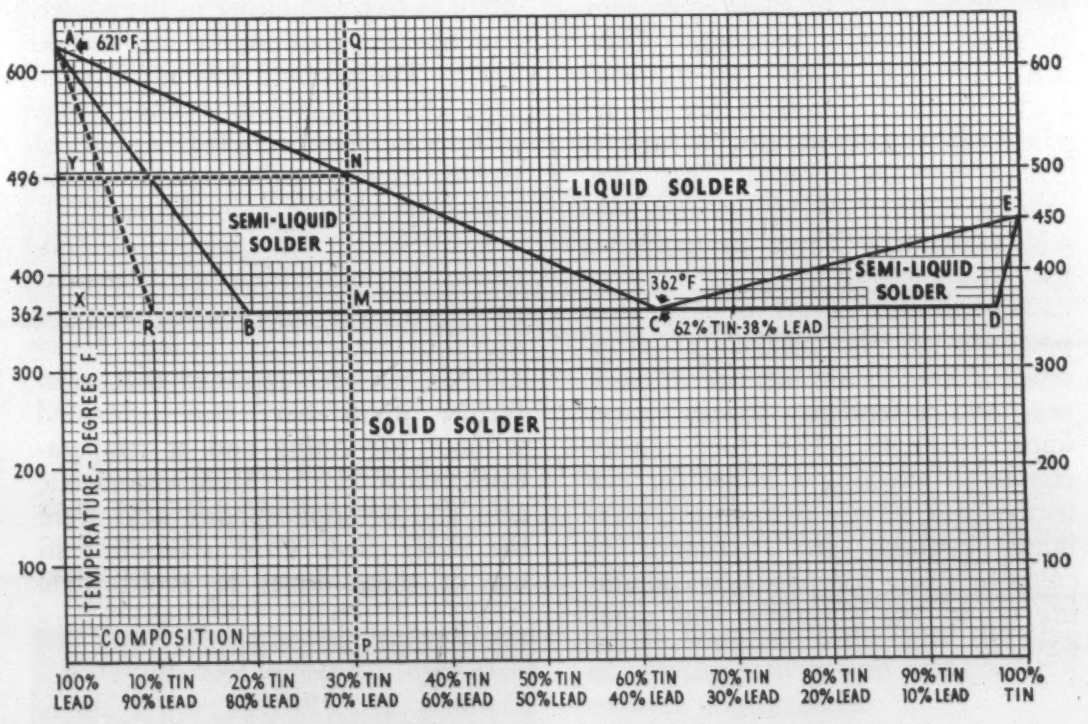
Dip *soldering is fast and efficient. Parts are dipped in molten solder which is usually at least 100 F above liquidus temperature for rapid heating. (Westinghouse Electric Corp.)*

tin and 80% lead has the widest melting range, it being 173 F.

Some of the commercial soft solders contain small amounts of other elements, such as antimony, silver and bismuth, which are added deliberately for the special properties they impart. Silver and antimony both tend to increase both the liquidus and solidus temperatures slightly, but make the solder brittle. Silver tends to lessen the decrease in strength due to aging, and antimony appears to increase the strength of solders. Antimony should not be used in solders for joining zinc, cadmium or galvanized metal, since it combines with these metals to form a brittle constituent.

In general, the bulk of the solders for joining metals other than aluminum and magnesium contain between 15 and 50% tin, 0 to 2% antimony, and balance lead. The trend in recent years has been to decrease the tin content as much as possible without sacrificing the quality of the joint.

Usually there are a number of different tin-lead compositions that could be used on a given joint, and final selection depends on many factors, such as cost, the base metal, permissible temperature of the joining operation, and service requirements. In many cases ease of application of the solder is the major consideration. The alloys containing between 40 and 50% tin have the best spreading qualities of the tin-lead series, and for this reason are frequently recommended when available and when economically feasible.



Tin-lead constitutional diagram. (Federated Metals Div.)

During periods when tin is in short supply or when the cost is prohibitive, low tin solders are frequently adopted for uses normally handled with higher tin solders. During World War II the 20 tin, 80% lead was established for general soldering purposes. The principal limitation of this particular low tin composition is its broad melting range, 170 F, which means a longer cooling period during which parts being soldered must not be moved.

Also, its spreading characteristics are generally not as good as those of the 50-50 composition.

As mentioned earlier, soft solders are not satisfactory for joints subjected to any appreciable stress. It is difficult to give even approximate figures on strength of soldered joints, for they vary considerably with a number of factors, such as type joint, base metal and joint thickness. However, to give a rough idea of the order of strengths achieved, it can be said that the short time tensile strengths of tin-lead soldered joints ranges from around 3700 psi to a maximum of about 6500 to 6800 psi for the eutectic composition. Under continuous load conditions strengths are considerably less; in the case of the eutectic composition, for example, it is about 300 psi.

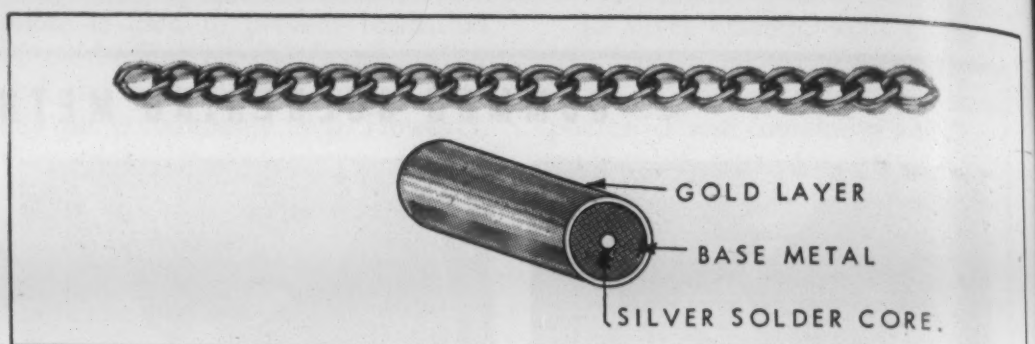
Shear strengths of tin-lead solder joints are usually 15 to 50% lower than the tensile strength. Impact strengths vary from about 12 ft-lb for the low tin solders to about 15 lb for the eutectic composition.

The solders lose strength with increasing temperatures. At 212 F most solders lose about 50% of their short time tensile strength; at 300 F only about 30% of their room temperature strength remains. There are, however, some tin-antimony high temperature solders that are applied where temperatures as high as 350 F are encountered. They contain from 94 to 96% tin and 4 to 6% antimony. These compositions melt at about 450 F.

The general effects of low temperatures on the mechanical properties of solders are increase in hardness and a tendency toward lower impact strength. The chief consideration in selecting a solder for low temperature service is to ensure maximum strength and resistance to creep by using compositions containing up to 1% antimony and about 65% tin.

Lead-Silver Solders

Lead-silver solders have proved useful as substitutes for tin-lead solders in a number of applications. The eutectic composition contains about 2.5% silver and has a melting point of about 590 F. It is very fluid when molten and can be used for general work. When a wider melting range is desired, the silver content is lowered to about 2.25% and 3% tin is added. Silver content can be raised to 5% to give better solderability.



This jewelry chain manufactured by Sweet Manufacturing Co. is made from a silver solder filled gold plate wire. After links have been formed the chain is put through an atmosphere furnace; the brazing alloy runs out of core just enough to fill the joint of each link. (General Plate Div.)

In general, the lead-silver solders are suited for applications where their relatively high soldering temperatures is not a handicap, and where strong acid fluxes can be used. As a class they are somewhat stronger, especially at elevated temperatures, than the conventional tin-lead solders.

Low Temperature Solders

The bismuth containing low temperature solders are used for special applications where a low melting point is required either in the soldering operation or in the application itself. The bismuth low melting alloys are produced in a wide range of melting temperatures; a few of the commonly used compositions for soldering are listed in Table 5.

In general, best results are obtained by pretinning with regular solders or with a bismuth low melting alloy chosen for the job. However, it has been reported that satisfactory joints have been obtained without pretinning and at temperatures below 212 F. Mono-chloracetic acid and orthophosphoric acid were the fluxes used. Care is required in use of these fluxes to avoid toxic fumes and to protect the workers' skin.

Table 5—Typical Low Melting Solders

Composition, %				Melting Range, F
Bi	Pb	Sn	Others	
58	—	42	Zn, 4	266
40	—	60	—	281–338
67	16	17	—	300–203
56	22	22	—	220–203
42.5	37.7	11.3	Cd, 8.5	158–194

Other Solders

There are a large number of little used solders, but only a few can be briefly mentioned here. Indium-tin-lead solders have been developed which resist corrosive action of strong alkaline solutions much better than conventional soft solders. The most desirable composition seems to be 25 indium, 37.5 lead and 37.5% tin. The high cost of indium restricts their use to those applications where their special properties are required.

Cadmium containing solders are excellent in many respects. A 95 cadmium, 5% silver alloy has been found useful for joints subject to higher temperatures than can be met by conventional solders. The solidus temperature of this alloy is about 640 F and the liquidus is 750 F. A 90 lead, 8 cadmium and 2% zinc alloy is useful for soldering zinc and galvanized parts. The melting range is about 410 to 530 F. A eutectic alloy, containing about 83 cadmium and 17% zinc, melting at 508 F, is reported good for soldering zinc-base die castings. These are but a few of the wide variety of soft solders available for special or specific applications.

Solders for aluminum, magnesium and high temperature materials are discussed elsewhere in this manual.

Soldering Fluxes

Perhaps the single most important factor in the production of a sound solder joint is the proper choice and correct use of the flux. In many cases the solder composition is very closely specified, but the flux is selected without regard to composition. It is advisable, however, to exert as much care in selecting the

flux as in selecting the solder. Fluxes are used for the same reasons enumerated in our earlier discussion of brazing fluxes. There is no one flux that is satisfactory for all soldering jobs. The many available are classified into two groups: corrosive or acid fluxes, and noncorrosive fluxes. The most common fluxes in these two groups are described briefly below. They are also listed in Table 6.

Corrosive Fluxes—Zinc chloride is the most commonly used corrosive flux. It has a melting point of about 500 F and, therefore, should not be used alone with solders containing more than 30% tin. Addition of 10% ammonium chloride effectively reduces the melting point, and by dissolving one part with three parts of zinc chloride in water the melting point will be reduced to 355 F. Ammonium chloride solution can be used alone as a flux, but is not as effective.

Solutions of hydrochloric acid or phosphoric acid make effective fluxes for soldering several different metals. Dilute hydrochloric acid alone or mixed with equal proportions of zinc chloride is useful for stainless steel. Inhaling the vapors should be avoided. Orthophosphoric acid in a 40% solution by volume is a good flux for steel, copper and brass. Paste fluxes are usually made by mixing the active fluxes in vaseline.

Zinc chloride fluxes with small amounts of ammonium or stannous chloride have proved satisfactory for lead-silver solders.

Noncorrosive Fluxes—Where flux residues cannot be removed by washing, relatively noncorrosive fluxes must be used. Rosin is the chief ingredient of this class of fluxes. Although not greatly reactive with common metals, it is sufficiently active at soldering temperatures to be useful in many applications. The big advantages of rosin are that its residue is noncorrosive, nonconductive, and does not absorb moisture.

Table 6—Soldering Fluxes

Flux	Characteristics	Use
Rosin	Noncorrosive, nonconducting, nonhygroscopic	Electrical
Tallow Olive Oil or Gallipoli Oil	Very mildly corrosive	Lead, brass, clean copper Pewter, block tin
Stearic Acid	Mildly corrosive, almost nonconductive	Electrical, lead
Aniline Phosphate or Aniline Chloride	Mildly corrosive, almost nonconductive	Electrical
Lactic Acid Pthalic Acid Phosphoric Acid Mixed with Tallow, Resin, Etc.	Mildly corrosive Slightly conductive	Electrical
Zinc Chloride	Corrosive	Iron, steel, zinc, copper, brass, bronze, terne, and lead plate
Zinc Chloride and HCl	Corrosive	Stainless steel, nickel and monel
Zinc Chloride + HF	Corrosive	Brasses and bronzes containing aluminum, silicon and manganese
Orthophosphoric Acid	Corrosive	High tensile Manganese bronze
Numerous Proprietary Pastes Usually Containing Zinc Chloride	Corrosive	—
Zinc Chloride and Ammonium Chloride	Corrosive	Iron, zinc, copper, brass, bronze
Dilute Hydrochloric Acid	Corrosive	Dirty zinc
Fused Salts of Zinc Chloride and Ammonium Chloride	Corrosive	On dip pots

Adapted from table by Reichelderfer and Gonser in Report No. W126 of War Metallurgy Committee, 1944.

Rosin in powder form is dissolved in a vehicle such as alcohol or turpentine and is used as liquid or paste.

Where rosin is not active enough, the so-called activated rosin fluxes can often be used to advantage. Many proprietary compositions have been devised by adding small amounts of organic acids or compounds to rosin to get increased chemical activity. It is usually a safe practice to test these compositions before adopting them since they are of varying activity and some are not entirely noncorrosive.

Brazing Alloys and Solders for Various Metals

Carbon and Low Alloy Steels

Brazing—The silver brazing alloys with general purpose fluxes are most widely used. In general, the silver should not be over 60% because wetting action decreases with silver content above this figure. There should be appreciable amounts of zinc, cadmium, tin or nickel to alloy with the steel. Copper and brass brazing alloys are also suitable. However, copper-phosphorus filler metals must be avoided, because of the formation of brittle iron phosphide.

Soldering—In general, any of the common lead-tin solders are suit-

able; tin content ranges from about 15 to 50%. Because of the ease of application, compositions with high tin content, 40 to 50%, are usually preferred. For high strengths at slightly elevated temperatures, tin-antimony and silver-lead compositions are often used.

Stainless Steels

Brazing—Silver brazing alloys are used extensively and are satisfactory for a wide variety of corrosive conditions. The compositions with low melting ranges, around 1200 F, are preferred in order to keep to a minimum the heat-affected zone. Borax or boric acid type fluxes are not suitable. A number of special proprietary fluxes are available which are satisfactory. Copper, and especially brass alloys, have a greater tendency than the silver alloys to cause intergranular penetration and attack; therefore, their use is limited. Where high chromium stainless steels subject to elevated temperatures must be brazed, a nickel-chromium base alloy has been found suitable, and is good for temperatures up to around 1800 F. A silver-manganese alloy can also be used for high temperature service up to around 900 F.

Soldering — Stainless steels are more difficult to solder than are copper alloys and plain steels because of the tightly adhering oxide film. Solders containing at least 50% tin are usually recommended. Active fluxes, such as the orthophosphoric type or hydrochloric acid saturated with zinc, are required to dissolve the surface oxide.

Cast Steels and Irons

Brazing and soldering cast iron is normally quite difficult because the graphitic carbon, high silicon content, and frequently sand particles, prevent satisfactory wetting and bonding. Electrolytic cleaning is the best method of treating surface prior to brazing or soldering. With proper surface preparation the brazing alloys or solders commonly used on steel are satisfactory. Quality controlled cast irons and nickel containing types are readily brazed compared to the other cast irons, and do not require electrolytic cleaning.

Cast steels can be brazed readily with silver alloys, preferably using compositions with a solidus temperature not over 1200 F. Copper and copper-base alloys are used only in furnace brazing employing a reducing atmosphere. No flux is required and the alloy is usually applied in the form of washers, sheet, wire and powder.

Copper and Copper Alloys

Brazing and soldering are widely used methods of joining copper and copper-base alloys. The silver brazing alloys having flow temperatures in the range of 1150 to 1600 F and the common lead-tin solders are most commonly employed.

Copper—All silver brazing compositions when used with the proper flux are suitable. Copper-phosphorus or copper-phosphorus-silver alloys can also be used; because they are self fluxing on copper, no flux is required. When brazing oxygen-bearing copper, reducing atmospheres should be avoided since the oxygen in the copper may combine with the atmosphere, causing brittleness.

The 50-50 tin-lead solders are generally most preferable, but in many applications are too expensive. Therefore, in practice, solders with tin contents of 30 to 40% are widely used. The allowable antimony content ranges from 0 to 2%. However, tin-antimony solders containing up to 5% antimony and balance tin can be used where higher strength is needed or where lead is not desirable. Zinc chloride type fluxes are preferable where cleaning after soldering is no problem; otherwise noncorrosive rosin type fluxes must be used.

Brasses—The high copper brasses are readily brazed with silver-base alloys and certain brass brazing compositions. Because of their low melting point the low copper brasses are only brazed with silver alloys. Leaded brasses can be brazed, but greater care is required to prevent lead from alloying with elements of the brazing material to cause brittleness. Fluxes containing fluoride salts are used with the silver alloys, and borax or boric acid type fluxes with brass brazing alloys.

Although the brasses present some difficulties in soldering, this is a normal means of joining them. Compositions containing 50% tin and lower are satisfactory; 60% tin solders yield best results. Antimony is not permissible (max. 0.5%) since it can cause brittleness in the joint. The most common soldering flux is zinc chloride.

Bronzes — The ease with which the bronzes can be brazed and soldered varies considerably with composition. All phosphor bronzes (copper-tin) can be brazed with silver alloys while the usual brass brazing alloys are suitable for the higher melting compositions only. The alloys with high tin content or with appreciable lead additions require more adequate flux protection. Phosphor bronzes are readily soldered with tin-lead alloys containing 30 to 50% tin, with the higher tin compositions being preferred.

In brazing aluminum bronzes (copper-aluminum) hard refractory oxides are formed and special fluxes must be used. Both silver and brass brazing alloys are suitable. Aluminum, silicon and manganese bronzes are rather difficult to solder, and special fluxes are needed to dissolve the oxides. One flux recommended is equal parts of hydrochloric acid and zinc chloride. Orthophosphoric acid has also been found useful, particularly for manganese brazing. Powdered solder mixed with flux is often preferred.

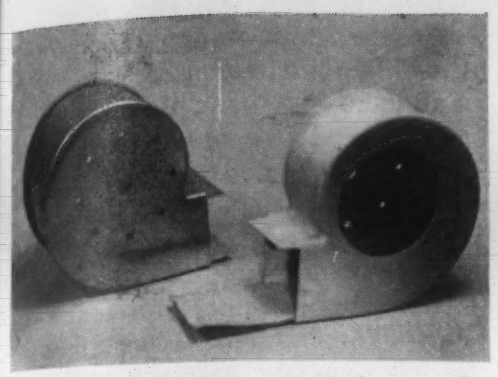
Beryllium Copper — The silver brazing alloys are generally used. When solution treatment is to follow brazing operation, silver alloys having melting points above 1425 F must be used. To avoid the very hard and refractory beryllium oxide, extra clean surfaces and a flux with high fluoride content are needed; also, brazing should be done immediately after cleaning and fluxing to avoid new oxide formation.

Tin-lead solders of the 50-50 type find widest use. For applications subject to moderately elevated temperatures, 95 tin-5% antimony or 97.5 lead-1.5 silver-1.0% tin solders can be used. Corrosive fluxes, such as zinc chloride or combinations of zinc, ammonium and stannous chloride, are suitable where parts can be cleaned after soldering. Where rosin type fluxes must be used, special attention should be given to precleaning.

Nickel Silver and Cupro Nickel—All copper alloys containing nickel are readily brazed with both silver and brass brazing alloys. Solders containing 35 to 50% tin, balance lead are satisfactory to soldering.

Nickel and Nickel Alloys

Brazing—Silver brazing alloys are most widely used on nickel and nickel alloys, and the low melting point compositions are preferred. Copper can also be used where the



Small blower housing stamped out of sheet aluminum and joined by brazing with special aluminum brazing alloy. (Eutectic Welding Alloys Corp.)

high melting temperature is not objectionable. Brazing alloys containing phosphorus should never be used. Chromium containing alloys, such as Inconel, are frequently copper plated before copper brazing. The high nickel alloys, and particularly monel, have a tendency to stress crack in the presence of molten low melting brazing alloys containing silver, cadmium or zinc. Therefore, when using these filler metals the material should be in annealed condition.

In corrosive applications brazing alloys containing at least 50% silver are preferred. Some of the silver alloys most commonly used are: 35 silver, 26 copper, 21 zinc, 18% cadmium; 45 silver, 15 copper, 16 zinc, 24% cadmium; 50 silver, 15.5 copper, 16.5 zinc, 18% cadmium. The following brazing alloys give good color match with nickel, monel and Inconel; 60 silver, 25 copper, 15% zinc; and 65 silver, 20 copper, 15% zinc.

The general purpose fluxes are usually satisfactory for brazing the nickel and nickel alloys. However, alloys containing aluminum require special fluxes. In silver and copper furnace brazing, no flux is needed if sulfur-free reducing atmosphere is used.

Soldering—The tin-lead solders of the 50-40 and 60-40 variety are most widely used. Occasionally pure tin is used where corrosion resistance demands it. Only the acid fluxes, such as zinc chloride and ammonium chloride, are suitable. A stronger flux is needed for soldering Inconel because of the presence of chromium oxide.

Titanium

Thus far not too much success has been achieved in brazing titanium. Both silver and aluminum brazing alloys have been tried. Although suitable fluxes have been found, joints made with silver-base alloys contain a brittle layer between the base metal and filler metal. Aluminum brazing alloys appear to be more satisfactory but produce relatively low strength joints. To date soldering of titanium has not met with success.

Aluminum and Aluminum Alloys

Brazing—There are two problems that make brazing of aluminum relatively difficult. For one thing, the tenacious oxide film present on aluminum and its alloys prevents the brazing alloy from wetting the surface. Fluxes, however, have been developed that remove the oxides from both the base and filler metals, serve as a protective coating against further oxidation, and assist the free flow of molten filler metal. Another problem is the small difference in melting point between brazing alloys and the base metal, which is usually less than 100 F.

At present four standard wrought alloys can be brazed commercially. They are commercially pure aluminum (2S), aluminum-manganese (3S), and the aluminum-magnesium-silicon alloys (53S and 61S). Any other wrought aluminum alloys of higher purity than type 2S can also be brazed.

Since the brazing temperatures for all these alloys is above the annealing temperature, they are all put in the annealed or soft temper condition when brazed. The heat treatable alloys, 53S and 61S, can be reheat-treated or, in some cases, quenched from the brazing operation to developed mechanical properties of the T4 temper. They can then be aged to the T6 temper. The same results can be obtained by following the brazing operation with a solution heat treatment, quenching and aging.

No satisfactory methods have been developed as yet for brazing 11S, 14S or 24S alloys. Although techniques have been worked out for certain aluminum casting alloys, the brazing of castings is still in the development stage. The melting ranges of cast alloys are generally lower than the nonheat-treatable alloys, and so the filler metals so far developed cannot be used.

The aluminum-silicon alloys listed in Table 7 are the only brazing alloys suitable for aluminum. For brazing the higher melting point alloys, 2S and 3S, the filler metal usually contains around 4 to 7% silicon (No. 43); for the lower melting point alloys, 53S and 61S, the composition is about 10 to 13% silicon (No. 718). The filler metals are produced in the form of wire, strip washers, clips, shims and rings. No. 713 is used only as a coating on brazing sheet. Nos. 43 and 713 are most suitable for brazing with furnace and dip methods; No. 718 is for torch brazing but can also be used for furnace and dip brazing. These filler metals are generally used with tee or lap joints.

In addition to the above, aluminum brazing sheet is available. This duplex sheet is produced by rolling a thin layer of brazing alloy on one or both sides of the base aluminum alloy. Products can be made from this material by any of the common forming methods and brazed without addition of any other filler metal. When parts made of brazing sheet are raised to the brazing temperature, the layer of brazing alloy melts and flows into the openings at the joints and seams.

The brazing sheet is available in various combinations of base alloy and brazing alloy as listed in Table 8. Nos. 11 and 12 brazing sheet have a 3S alloy core and produce brazed joints of good ductility and a tensile strength in excess of 14,000 psi. Nos. 21 and 22 have the lowest melting point coating, and when used, minimize sagging and distor-

Table 7—Aluminum-Silicon Brazing Alloys

Designation	Nominal Composition, %		Solidus, F	Liquidus, F	Brazing Range, F	Standard Form	Size, In.
	Si	Al					
43	4–6	Rem.	1070	1165	1150–1185	Wire in coils and strip	Round, 1/16 to 3/16
718	11–13	Rem.	1070	1080	1090–1185		0.020 by 2
713	6.8–8.2	Rem.	1070	1135	1120–1140	Coated sheet	0.006 to 1/4

Table 8—Aluminum Alloy Brazing Sheet

Designation	Sides Coated	Core	Coating	Thickness of Each Coating, In.	Brazing Range, F
11	1	Alcoa 3S	713	0.063 and less, 10%	1110–1140
12	2	—	—	0.064 and over, 5%	—
21	1	Alcoa J51S	713	0.090 and less, 10%	1110–1120
22	2	—	—	0.091 and over, 5%	—

tion, and reduce the possibility of melting the parent metal during brazing. Nos. 21 and 22 have a heat-treatable core. Therefore, by quenching directly from the brazing operation or if given subsequent heat treatment, properties of the solution-treated material are developed. Thus, brazed joints in this condition will show a strength in excess of 24,000 psi. By following this with a precipitation heat treatment, strength can be raised to 35,000 psi or over.

Brazing sheet has wide application. It is particularly suited for furnace and dip brazing. It can also be torch brazed, but certain precautions must be taken.

There are several different aluminum brazing fluxes available to meet a wide range of requirements. Four fluxes of the Aluminum Co. of America are typical of the types available. They are composed of chlorides, fluorides and other metal salts, and are produced in the form of finely divided powder. Because of the fluorides contained in them, these fluxes should be used with caution and the instructions of the suppliers should be closely followed.

The fluxes are designated Nos. 30, 33, 34 and 53. The lowest melting point flux is No. 33, a general purpose flux which is most active chemically, gives maximum flow of filler metal, and is used at brazing temperatures of 1100 F and below. No. 30 flux has a higher melting point than No. 33, is almost as active, and can be used on 2S, 3S and Nos. 21 and 22 brazing sheet alloys at brazing temperatures above 1100 F. No. 53 is only slightly chemically active and, therefore, is ideally suited for brazing thin wall components (0.020 in. and less) and applications when a smooth surface is important. It is generally used at 1100 F and above. No. 34 is the lowest in cost, is not active chemically, and can be used on thin sections. It is satisfactory at temperatures of 1090 F and above.

Not much definite data are available on the corrosion resistance of brazed aluminum joints. Salt spray and exposure tests have indicated their corrosion resistance to be about the same as that of welded joints in the same alloy. Since brazing alloys are aluminum-base alloys, the possibility of electrolytic corrosion is considerably reduced.

Soldering—Although soldering of aluminum and its alloys can be done, it is not as easily accomplished as soldering some of the other common metals. An important limitation is corrosion resistance. Since all solders contain metals that have solution potentials different from those of aluminum alloys, a soldered joint can disintegrate rapidly through galvanic corrosion when exposed to moisture. Therefore, soldered joints can only be used in applications where the joint will be kept dry.

In the actual soldering operation, the high thermal conductivity of aluminum is perhaps the major problem. There are a number of brazing alloys and special fluxes on the market for soldering aluminum, and each requires special treatment and the following of definite instructions to produce satisfactory results. Tin-zinc solders containing 50 to 75% tin are generally preferred and should be applied with a non-oxidizing flame. Aluminum surfaces that have been properly alloyed with aluminum solder can be joined with the common soft solders and fluxes. Soldered joints can be made on any of the commercial forms of 2S or aluminum of higher purity. Aluminum and other metals, such as iron, steel, brass and nickel, can be successfully soldered together by either plating the aluminum first with copper or by tinning the aluminum surface and then using ordinary tin-lead solder and flux.

Magnesium and Magnesium Alloys

Brazing — At the present time commercial brazing is limited to M1 alloy (magnesium plus 1.5% manganese). The wide freezing ranges and extremely low solidus temperatures of most of the other magnesium alloys make it very difficult to find a filler metal that has a low

Table 9—Brazing of Magnesium Parts

	Brazing Methods		
	Furnace	Torch	Flux Dip
Alloy Brazed	M1 sheet and extrusion	M1 sheet and extrusion	M1 sheet and extrusion
Brazing Alloy	AZ92+0.002% Be (Min) AZ125+0.002% Be (Min)	AZ125	AZ92
Temperature	1130–1160 F	—	1120–1130 F
Flux	Dow 451 Dow 452	Dow 450 Dow 451 or 452	Dow 450 Dow 451 or 452
Flux Application	Dry flux powder Chlorbenzol paste	Dry flux powder Alcohol paste	—
Types of Joints	Lap and fillet	All types	Lap or fillet with recessed grooves for retaining filler alloy
Clearances	0.004–0.010 in.	0.004–0.010 in.	0.004–0.010 in.
Strengths of Joints	14,000–16,000 psi	18,000–23,000 psi	14,000–16,000 psi
Brazing Equipment	Electric or gas fired furnaces. Control within ± 5 F	Oxyacetylene air-natural gas	Electric or gas heated pot settings

melting range.

The brazing of another magnesium alloy, AZ31, is in the development stage. While it is possible to braze this alloy, the filler materials must be of high alloy content and, therefore, are somewhat brittle.

Of the alloys thus far investigated, AZ92 alloy (9 aluminum, 2% zinc, balance magnesium) offers the best all-around properties as a brazing alloy. It possesses ductility, corrosion resistance, capillary flow, high strength and sufficiently low melting point for brazing M1 magnesium alloy. The liquidus temperature of AZ92 is 1106 F, making it possible to braze at 1130 to 1160 F, which is safely below the solidus of M1. It is used most in torch, furnace and dip brazing. For furnace brazing it is supplied with a small amount of beryllium which prevents possible ignition.

Another magnesium alloy, AX125, containing 12 aluminum and 5% zinc, can be used for torch brazing. Because of its lack of ductility it cannot be readily formed into rings, washers or other shapes for preplacement. It has excellent capillary flow at 1075 to 1100 F.

Special chloride fluxes consisting of potassium chloride, sodium chloride and lithium chloride with small amounts of various fluorides are used in brazing magnesium. Dow 451 flux (1000 F MP) is used with AZ92 filler alloy, and Dow 452 (720 F MP) is used when brazing AZ125.

Table 9 summarizes the factors involved in brazing magnesium and gives the joint strengths that can be expected. In general, the strength of furnace brazed joints in M1 alloy is about 15,000 psi, which is about equal to the strength of M1 alloy after being heated to around 1150 F. The corrosion resistance of brazed joints is good if proper removal of flux is accomplished and there is no galvanic corrosion problem.

Soldering—Soldering is generally used only to fill small surface defects in castings, and small dents in sheet material. Because of the low

Table 10—Brazing Alloys for Joining Various Similar and Dissimilar Materials

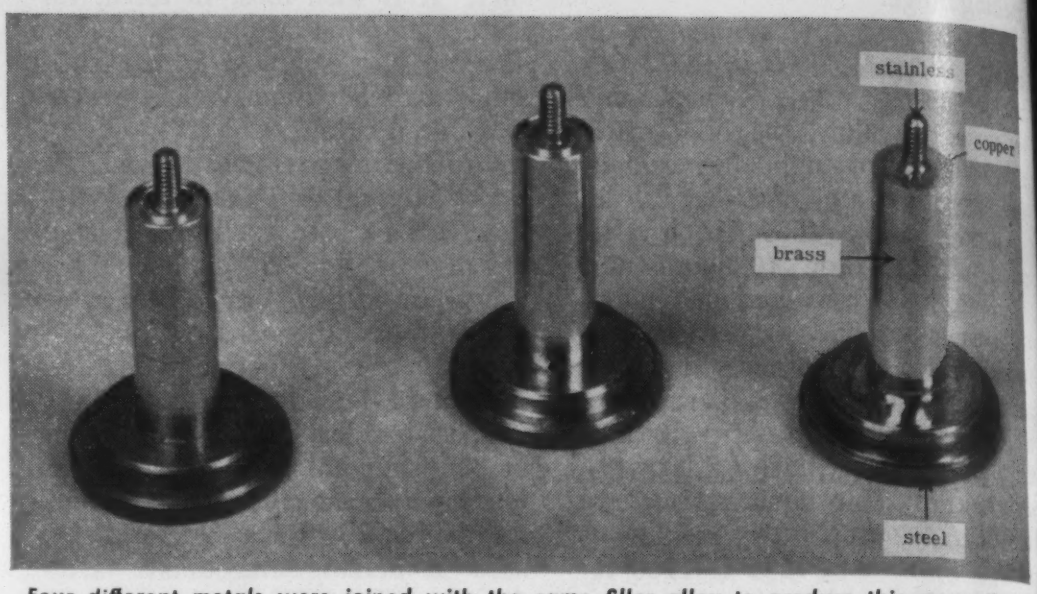
This table is not exhaustive. The brazing and soldering materials listed are those which are most commonly used under normal service conditions.

	Carbon and Low Alloy Steels	High Carbon and Tool Steels	Stainless Steels	Cast Irons	Copper	Brasses	Bronzes	Aluminum and Aluminum Alloys	Magnesium and Magnesium Alloys	Nickel and Nickel Alloys	Heat Resistant Alloys
Carbon and Low Alloy Steels	Ag Cu CuZn	Ag Cu CuZn NiCr	Ag CuZn NiCr Cu	Ag Cu CuZn	Ag Cu CuZn	Ag CuZn	Ag CuZn	—	—	Ag Cu CuZn	AgMn NiCr Ag Cu
High Carbon and Tool Steels	—	Ag Cu CuZn NiCr	Ag CuZn NiCr	Ag Cu CuZn	Ag CuZn Cu	Ag CuZn	Ag CuZn	—	—	Ag Cu NiCr	Ag Cu NiCr AgMn
Stainless Steels	—	—	Ag,Cu NiCr AgMn	Ag	Ag	Ag	Ag	—	—	Ag,Cu NiCr AgMn	Ag,Cu NiCr AgMn
Cast Irons	—	—	—	Ag Cu CuZn	Ag CuZn	Ag CuZn	Ag CuZn	—	—	Ag Cu	Ag Cu NiCr AgMn
Copper	—	—	—	—	Ag CuZn CuP	Ag CuZn	Ag CuZn	—	—	Ag Cu	Ag Cu
Brasses	—	—	—	—	—	Ag CuZn	Ag CuZn	—	—	Ag CuZn	Ag
Bronzes	—	—	—	—	—	—	Ag CuZn	—	—	Ag CuZn	Ag CuZn
Aluminum and Aluminum Alloys	—	—	—	—	—	—	—	AlSi	—	—	—
Magnesium and Magnesium Alloys	—	—	—	—	—	—	—	—	MgAZ92	—	—
Nickel and Nickel Alloys	—	—	—	—	—	—	—	—	—	Ag Cu CuZn NiCr AgMn	Ag Cu CuZn NiCr AgMn
Heat Resistant Alloys	—	—	—	—	—	—	—	—	—	—	AgMn NiCr CuZn Ag Cu

CODE: *Ag = Silver base*
Cu = Copper
CuP = Copper-phosphorus
AlSi = Aluminum silicon
NiCr = Nickel = chromium = base alloy
AgMn = Silver--manganese alloy

strength and brittle joints obtained, soldering is not recommended where the area must withstand stresses. Nor is it ordinarily suitable for joining magnesium to other metals.

There are three commonly known solders for magnesium. One has a composition of 60 cadmium, 30 zinc and 10% tin, and starts to melt at 315 F. It is suitable for general soldering. Another has a composition of 90 cadmium and 10% zinc, and a melting point of 500 F. A third solder is similar to those used on aluminum, contains 60 tin and 40% zinc, and has a melting point of 630 F.



Four different metals were joined with the same filler alloy to produce this magnetic gas valve. Hole at base (center) was drilled to permit alloy to flow around joint inside base. (Eutectic Welding Alloys Corp.)

Brazing Alloys for Dissimilar Materials

One of the big advantages of brazing is that it can be used to join a wide variety of dissimilar materials. In selecting the brazing filler metal the main consideration is to choose one which would be satisfactory for either of the metals alone. It should be evident that the final choice is usually a compromise, since only seldom is a given brazing alloy equally satisfactory for both base metals. Table 10 shows the brazing alloys generally most suitable for various metal combinations.

The choice of flux is often quite difficult because it must satisfy the requirements imposed by both the filler alloy and the dissimilar materials being joined. In most cases the commercial suppliers of brazing materials should be consulted.

Other Metals

Molybdenum—Thin sheets can be brazed with copper or silver brazing alloys using a spot or seam welder. For applications in which melting points are higher than those of the conventional brazing alloys, nickel or tantalum foil can be used, the operation being done under water to prevent oxidation of tantalum.

Tungsten — Copper, nickel or other high temperature brazing alloys can be used to braze tungsten to itself and to some other metals. Conventional spot and seam welding equipment is satisfactory. No flux is required when parts are cleaned thoroughly. For high temperature service, tantalum foil can be used with brazing being done under water to prevent oxidation.

Zinc and Zinc Alloys—Because of their low melting points, zinc and zinc alloys cannot be brazed. The regular grades of wrought zinc are relatively easily soldered. Zinc die castings are not often soldered. Soldering is most successful using a cadmium-zinc eutectic alloy (82.5 cadmium and 17.5% zinc) without flux.

Gold and Platinum and Silver—Gold brazing alloys are principally used for joining gold and gold alloys. They usually contain some copper, silver and zinc. Platinum and platinum alloys are brazed with fine gold or the higher karat gold alloys. A wide variety of silver brazing alloys are used for joining silver. In general, they contain from 60 to 75% silver and frequently are formulated to give a color match.

Heat Resistant Materials — As pointed out earlier, nickel-chromium and silver-manganese alloys are the principal brazing alloys for heat resistant metals and alloys such as stainless steels and nickel alloys. For some applications copper and nickel are also suitable.

Plated and Dipped Parts

Included in this group are tin, zinc, cadmium, copper, silver, nickel, chromium and terne plates. Of this group only the chromium plate cannot be satisfactorily soldered, but the types of solders used on the others vary greatly. Surfaces such as tin, cadmium and silver, when cleaned, are so easy to solder that rosin base fluxes can be used with high grade solders such as 40 tin-60% lead, 50 tin-50% lead and 60 tin-40% lead. On surfaces such as zinc, copper, nickel and terne, the soldering operation requires a stronger flux and here the solders 15 tin-85% lead to 50 tin-50% lead again are applicable. In the can making industry where tin plated or dipped surfaces are used with the chloride fluxes, solders with 5% and less tin are used successfully and these solders daily become more popular as the methods of handling them become better known.

Acknowledgments

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Air Reduction Sales Co.
Aluminum Co. of America
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Bridgeport Brass Co.
Chase Brass & Copper Co.
Copper and Brass Research Assn.
Dow Chemical Co.
Eutectic Welding Alloys Corp.
Federated Metals Div.
Gasflux Co.
General Plate Div.
Handy & Harman
International Nickel Co.
Kester Solder Co.
D. E. Makepeace Co.
Metals Disintegrating Co., Inc.
Mueller Brass Co.
Revere Copper and Brass, Inc.
Reynolds Metals Co.
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Westinghouse Electric Corp.
Whitehead Metal Products Co., Inc.

Materials Engineering File Facts

NUMBER 223
March, 1952

MATERIAL: Steel

New Steel Compositions to Conserve Critical Alloying Elements

(These steels supplement those published in the October 1951 issue)

Standard Steels

Grade	Chemical Composition Limits, %				
	C	Mn	Si	Cr	Mo
4118	0.18/0.23	0.70/0.90	0.20/0.35	0.40/0.60	0.08/0.15
5155	0.50/0.60	0.70/0.90	0.20/0.35	0.70/0.90	—

New Steels Developed to Conserve Nickel

These two steels are intended for oil well drilling equipment, such as rock bit cutters, as alternates for the 48XX grades.

Grade	Chemical Composition Limits, %				
	C	Mn	Si	Ni	Mo
TS 4613	0.10/0.15	0.45/0.65	0.20/0.35	1.65/2.00	0.25/0.35
TS 4618	0.15/0.20	0.45/0.65	0.20/0.35	1.65/2.00	0.25/0.35

Alternate Boron Steels

The TS 43BV12 grade is intended as an alternate to the 33XX and 93XX grades for aircraft engine parts; the TS 43BV14 grade as an alternate to the 33XX, 48XX and 93XX grades for heavy duty truck parts; and the TS 46B12 as an alternate to the 48XX grade for oil well drilling equipment, such as rock bit cutters.

Grade	Chemical Composition Limits, %						
	C	Mn	Si	Ni	Cr	Mo	V
TS 43BV12	0.08/0.13	0.75/1.00	0.20/0.40	1.65/2.00	0.40/0.60	0.20/0.30	0.03 Min
TS 43BV14	0.10/0.15	0.45/0.65	0.20/0.35	1.65/2.00	0.40/0.60	0.08/0.15	0.03 Min
TS 46B12	0.10/0.15	0.45/0.65	0.20/0.35	1.65/2.00	—	0.20/0.30	—

Tentative Standard Boron Steels

Grades having the same numbers were published previously as supplementary information.

Grade	Chemical Composition, %					
	C	Mn	Si	Ni	Cr	Mo
TS 14B35	0.33/0.38	0.75/1.00	0.20/0.35	—	—	—
TS 14B50	0.48/0.53	0.75/1.00	0.20/0.35	—	—	—
TS 40B37	0.37/0.40	0.70/0.90	0.20/0.35	—	—	0.08/0.15
TS 50B50	0.48/0.53	0.75/1.00	0.20/0.35	—	0.40/0.60	—
TS 50B60	0.55/0.65	0.75/1.00	0.20/0.35	—	0.40/0.60	—
TS 80B37	0.35/0.40	0.75/1.00	0.20/0.35	0.20/0.40	0.20/0.35	0.08/0.15
TS 81B40	0.38/0.43	0.75/1.00	0.20/0.35	0.20/0.80	0.35/0.55	0.08/0.15

NOTE 1—The boron steels can be expected to have 0.0005% minimum boron content.

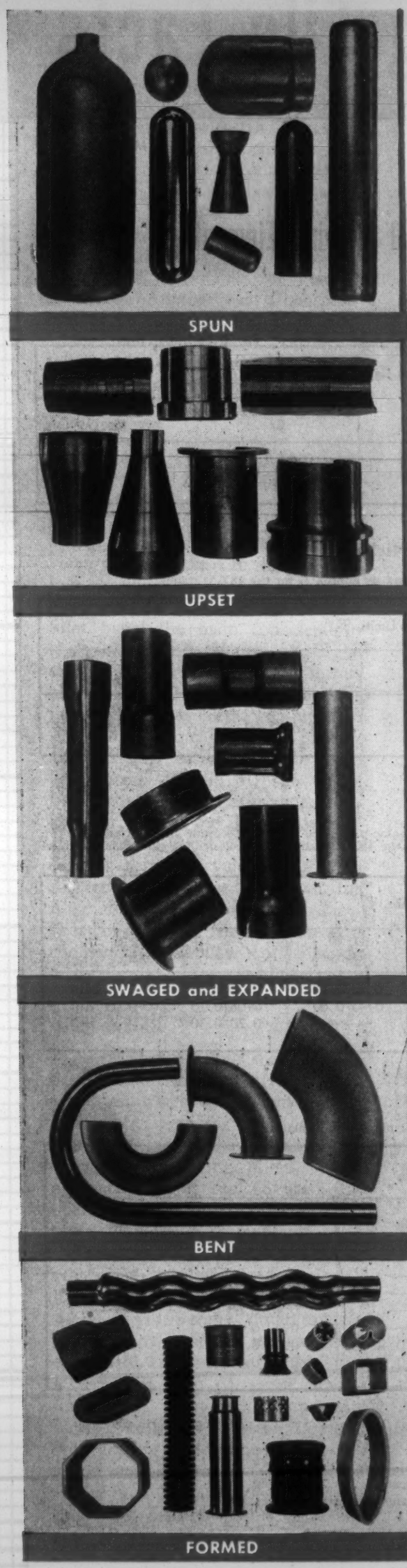
NOTE 2—The phosphorus and sulfur limitations for each steel-making process are as follows: basic electric furnace, 0.025 max %; basic open hearth, 0.04 max %; acid electric furnace, 0.05 max %; and acid open hearth, 0.05 max %.

NOTE 3—Minimum silicon limit for acid open hearth or acid electric furnace alloy steel is 0.15%.

NOTE 4—Small quantities of certain elements are present in alloy steels which are not specified or required. These elements are considered as incidental and may be present in the following amounts: 0.35 copper, 0.25 nickel, 0.20 chromium and 0.06 molybdenum.

NOTE 5—These steels have been approved by the Iron and Steel Technical Committee of the Society of Automotive Engineers, Inc.

Courtesy American Iron and Steel Institute



let's take a CLOSER LOOK at Fabrication Requirements

If you make hollow parts the economical way—from tubing—chances are you have one or more fabricating problems. This typical array of parts illustrates the wide range in severity of working that is involved in such operations as spinning, swaging, expanding, upsetting, bending, and forming. A corresponding diversity exists in the type, grade, finish, and mill condition of seamless and welded steel tubing used for their manufacture.

Remember, tubing is more than bar stock with a hole in it. It is a semi-finished product. B&W's ability to match its tubing to a myriad of end uses may enable you to make a better product . . . easier. Ask Mr. Tubes—your B&W Tube Company Representative—for help in selecting the tubing that is best for *your* fabricating requirements. Request a copy of Bulletin TB-324.

TA-1641-M

THE BABCOCK & WILCOX COMPANY
TUBULAR PRODUCTS DIVISION

General Offices & Plants

Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill. • Cleveland 14, Ohio
Denver 1, Colo. • Detroit 26, Mich. • Houston 2, Texas • Los Angeles 17, Calif. • New York 16, N.Y.
Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Calif. • Syracuse 2, N.Y.
Toronto, Ontario • Tulsa 3, Okla.

Materials Engineering File Facts

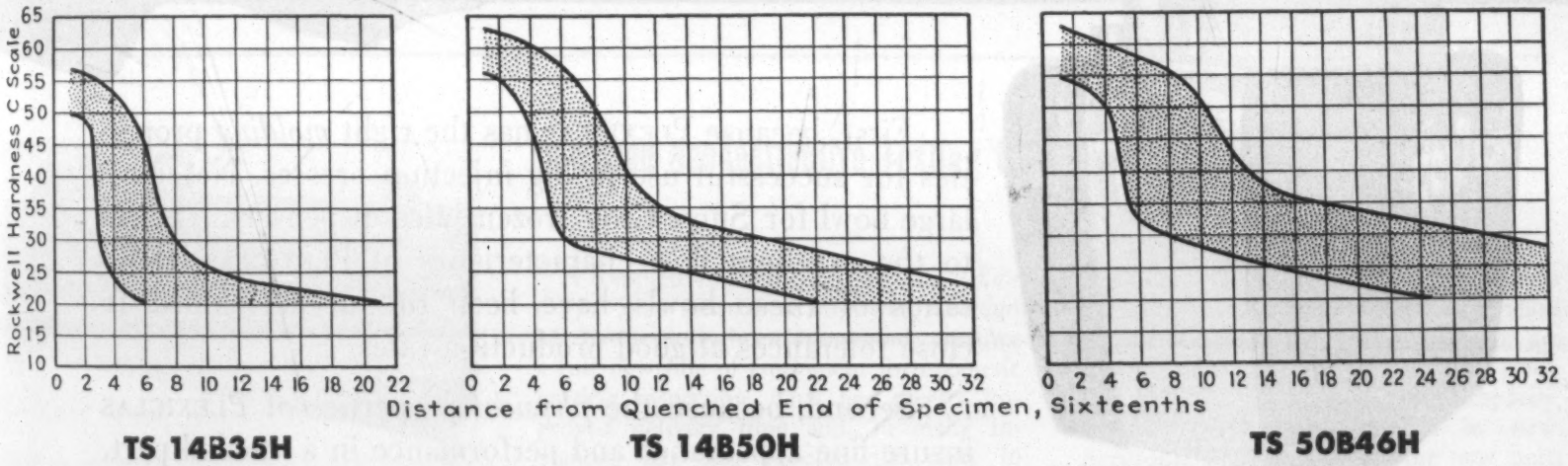
NUMBER 224
March, 1952

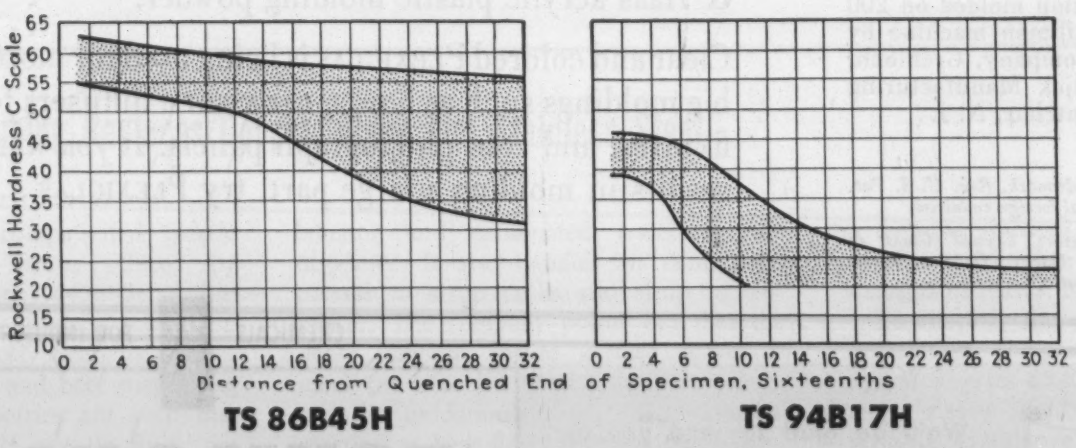
MATERIAL: Steel

Tentative Hardenability Bands for New Boron Steels

Steel Designation SAE or AISI	Chemical Composition, %*					
	C	Mn	Si	Ni	Cr	Mo
TS 14B35H	0.33/0.39	0.65/1.10	0.20/0.35	——	——	——
TS 14B50H	0.47/0.54	0.65/1.10	0.20/0.35	——	——	——
TS 50B46H	0.43/0.50	0.65/1.10	0.20/0.35	——	0.13/0.43	——
TS 86B45H	0.42/0.50	0.70/1.05	0.20/0.35	0.35/0.75	0.50/0.80	0.08/0.15
TS 94B17H	0.14/0.21	0.70/1.05	0.20/0.35	0.25/0.65	0.25/0.55	0.08/0.15

** These steels can be expected to have 0.0005% minimum boron content.*

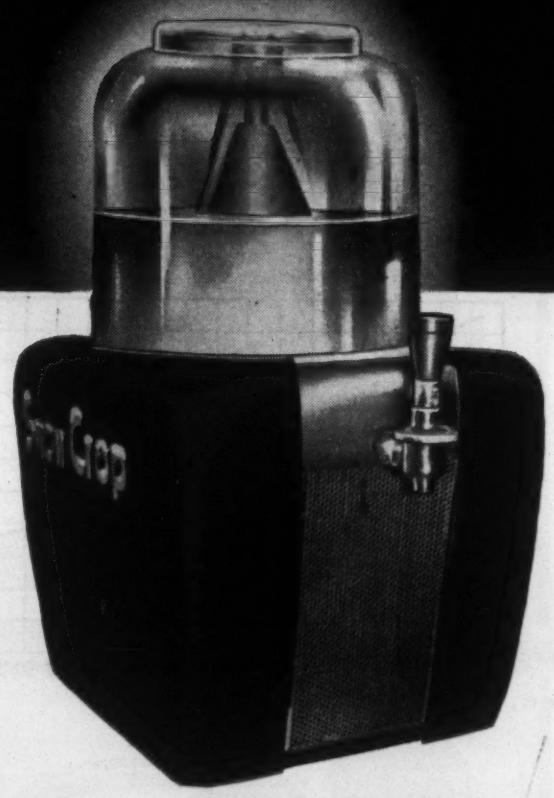



Rockwell Hardness C Scale
65 60 55 50 45 40 35 30 25 20 15 10
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
Distance from Quenched End of Specimen, Sixteenths
TS 86B45H
TS 94B17H

Courtesy American Iron and Steel Institute

For Large Injection-Molded Parts . . .

PLEXIGLAS



Bowl and cap for Snow Crop dispenser, molded of clear PLEXIGLAS "V". Bowl is 10½" high, has base diameter of 12½", weighs 4.25 pounds. Injection molded on 200 oz. Watson-Stillman machine by A. L. Hyde Company, Grenloch, N. J., for Oiljak Manufacturing Company, Montclair, N. J.

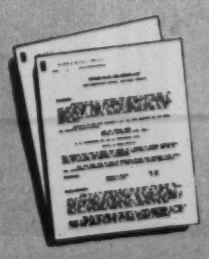
. . . First, because PLEXIGLAS has the right *molding* properties for successful use in big injection presses. Note this large bowl for Snow Crop frozen juice dispensers. Thanks to the excellent flow characteristics of PLEXIGLAS, thousands of these bowls have been produced, molded to close tolerances at good production rates.

. . . Second, because the *physical* properties of PLEXIGLAS insure fine appearance and performance in a molded part. Here, the requirements of exceptional clarity, resistance to chemical action, dimensional stability, and strength to withstand sudden impact, were met by use of this Rohm & Haas acrylic plastic molding powder.

Clear and colored PLEXIGLAS is being used for more and more big moldings such as bowls, car visors, diffusers for lighting fixtures, and coin phonograph panels. If *you* want the best results in molding a large part, try PLEXIGLAS . . . for size.

PLEXIGLAS is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.

Canadian Distributor: *Crystal Glass & Plastics, Ltd., 130 Queen's Quay at Jarvis Street, Toronto, Ontario, Canada.*



We'll be glad to send you our technical literature on PLEXIGLAS powders for injection and extrusion molding—and to discuss your specific application. Write us about your problem.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA 5, PA.

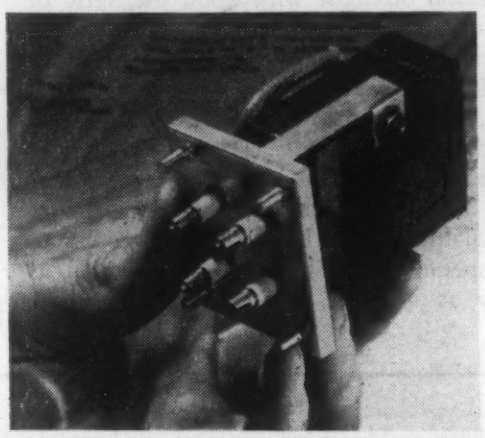
Representatives in principal foreign countries

New Materials and Equipment

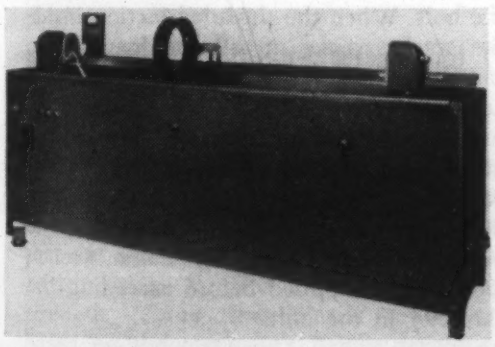
Iron-Silicon Laminations Designed for High-Frequency Inductors

Thomas & Skinner Steel Products Co., 1120 E. 23rd St., Indianapolis, has announced the introduction of OrthoSil, a new, 4-mil iron-silicon material for laminations, designed especially for high frequency inductors. These laminations are said to have exceptionally high permeabilities, from very low to very high inductions with correspondingly low core losses. OrthoSil is oriented to provide directional magnetic characteristics, and was developed primarily for frequencies of from 400 to 2,000 cycles. The new product is also adaptable to audio ranges.

The company advises that the material is available in standard as well as special shapes. The UI and EE series are designed particularly for OrthoSil, and are said to be excellent for 400-cycle applications. Transformers (such as power and 3-phase), chokes, saturable reactors and filters are just a few of the many electrical components for which the new material has been designed.



With certain metals, especially nickel, becoming scarce, the new iron-silicon material for laminations is finding many uses, including the transformer shown here.



New type Magnaflux unit is shown here —the direct current type ARQ, with a 96-in. capacity and 6,000-amp. magnetizing current output.

Improved Nondestructive Testing Units Offered

A complete re-engineering by *Magnaflux Corp.*, 5900 Northwest Highway, Chicago 31, has recently been announced, creating a full new line of equipment for magnetic particle inspection. This has greatly improved delivery time and, in many instances, has also reduced the costs to meet the expanding use of nondestructive testing, which had been created due to the needs of the national defense program.

A number of detailed improvements were made on the new line of standard units. In most cases the new units are larger than the old, at comparable price, from 48 in. old to 54 in. new capacity, and from 72 in. old to 96 in. new. According to the company, the new units can handle a greater diversity of parts for inspection. They are now built for either 220 or 440 volts, 60 cycle, interchangeably.

Flexible Plastic Tubing Replaces Copper, Block Tin, Stainless Steel

A new, specially compounded plastic tubing is currently being offered by *Hudson Industries, Inc.*, 4400 St. Aubin Ave., Detroit 7. Uses for the tubing up to this date have largely been in connection with soft drinks and beer dispensing systems, but its properties are such that it offers many possible uses in fluid, gas or low vacuum pressure systems.

According to the company, the tubing has proved satisfactory for conveying carbon dioxide gas and water to the carbonator and carbonated water to the dispenser. It also handles air from compressor to sirup tanks and sirup to dispenser. The company points out that the dense, smooth inside surface makes it ideal for beer line use since there is no metallic oxidation to set up a chemical reaction as beer flows through the tube.

Flexlite tubing is said to remain flexible, will not harden with age, nor dry out, become brittle or crack. It has no moisture absorption. Its tensile strength is 600 psi at room temperature of 70 F. As the temperature decreases, the tensile strength increases. Melting point is 250 F.

To simplify the use and make for easy installation, company engineers have designed a series of fittings. The tube insert has a fluted shank which is almost impossible to remove after it has been installed. A special stainless steel spring clamp is ensheathed over the tubing connection. The tubing is offered in 1/4- and 3/8-in. I.D; larger sizes available soon.

Polyester Film Offers Unusual Electrical, Physical and Chemical Properties

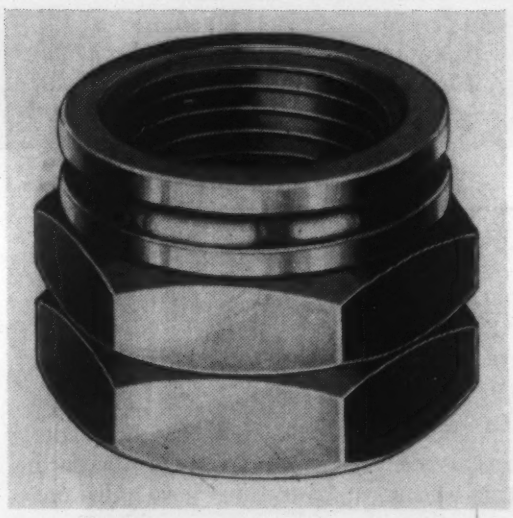
Development of a new polyester film which resembles cellophane in appearance, but is said to have unique electrical, physical and chemical properties, has been announced by *E. I. du Pont de Nemours & Co., Inc.,* Wilmington 98. One of the outstanding characteristics of Mylar is that it combines exceptionally high mechanical strength with good dielectric or insulating properties over a wide temperature range.

It has a high tensile strength of 25,000 psi, equivalent to about one-third that of high-strength steel. Also, its impact strength is said to be at least twice that of any known commercial film. As an insulator, it can be used in surrounding temperatures as high as 392 F and as low as —58 F, and at the same time exhibit exceptionally high mechanical strength, high dielectric strength, good resistance to attack by chemicals and oils, and a high degree of freedom from electrical faults in thin sections.

Among the electrical uses suggested for the new film are: As a capacitor dielectric, Mylar polyester film's combination of high mechanical strength with high dielectric strength in extremely thin sections should result in space saving. Its ability to operate at high temperatures will make it possible for capacitor manufacturers to enter many fields of end use, inaccessible before because of temperature limitations of conventional capacitor dielectrics.

Many properties are said to recommend the film for use as a motor and generator insulation. Notably, its insensitivity to moisture should greatly simplify the design and assembly of motor and generator units. Mylar is said also to effect savings in space, in production time, and in cost on such operations as coil winding and wire wrapping. Its mechanical strength and insensitivity to moisture may permit its use in so-called "open" coil construction. A property that recommends it for cable designs and conductor insulation is that the film is almost ideally suited for use on high-speed tapping machines.

Finally, it appears to meet electric insulation requirements in many special military applications. Its high mechanical and dielectric strength in thin sections should meet the growing demand of the military for miniaturization and reduction in weight of airborne equipment.



This nut is manufactured in various materials and will withstand temperatures up to 1600 F without thread seizure.

Seating Type Metal Locknut Is Free-Running

A seating type all-metal, free-running, self-energizing locknut that is usable over and over again is offered by *Klincher Locknut Corp.,* 2153 Hillside Ave., Indianapolis.

The grooved washer at the bottom of the nut is pressed over the threaded section suspended from the main body of the nut. This nut is manufactured in various materials and will withstand temperatures up to 1600 F without thread seizure.

The nut spins freely on the bolt down to the work. After the proper torque has been applied, the washer compresses, causing the threaded section inside the washer to move in and lock radially on the bolt. When the threaded section inside the washer picks up all the load it can carry, it elongates a few thousandths of an inch, permitting the bulk of the load to move up into the main body of the nut. This is said to reduce the high stress concentration and torsional load normally found in the first three threads of the nut and bolt, permitting more wrench torque to be applied before exceeding the elasticity in the bolt.

Resin Combines High Gloss, Fast Curing Properties

The *Rohm & Haas Co.,* Philadelphia 5, has announced the development of a new alkyd-modified, triazine, formaldehyde resin, designated as Uformite M-311, which is said to combine a number of significant properties difficult to obtain in a single resin.

According to the company, the resin imparts to enamel formulations the outstanding features of high gloss; fast curing speed; high soap, alkali, hot water, and humidity resistance; together with excellent color retention and film uniformity. It thus combines the properties needed for production of highest quality white baking enamel for washing machines, refrigerators, stoves, kitchen cabinets, and similar appliances and equipment.

Uformite M-311 is supplied at approximately 50% solids, on a solid basis. It contains 60% nitrogenous resin and 40% alkyd. It is compatible with short oil alkyds of the oxidizing and nonoxidizing types, generally used in white baking enamel formulations, such as Duraplex A-27, A-29, ND-77B and ND-78. It has only a limited compatibility with medium oil alkyds, and is incompatible with Duraplex D-65A, a long oil alkyd. It is, however, compatible in all proportions with other amine resins, such as Uformite F-200E, MM-55 and MX61.

Enamels containing the new resin have good storage stability; however, increases in viscosity will occur if the enamels are stored at high viscosities. Uformite M-311 enamels are said to have proved extremely durable under the interior exposure conditions which are usually encountered in the service life of household appliances. Indications are, however, that durability under outdoor conditions may not be quite as good as that of certain melamine resins made to withstand these conditions.

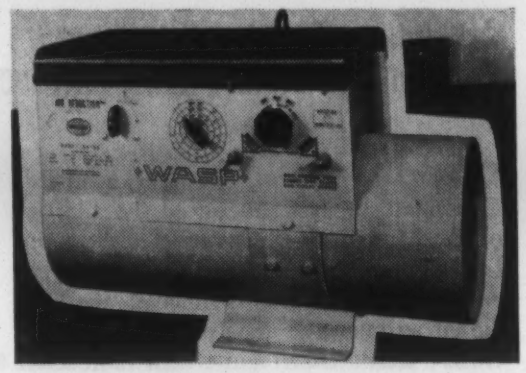
When maximum resistance to salt spray, soap, alkali, grease and other chemicals is needed, it is important to bake the enamel properly. A bake of 30 min. at 300 F appears to be the best for developing the maximum chemical resistance.

D.C. Arc Welders Provide Many Advantages

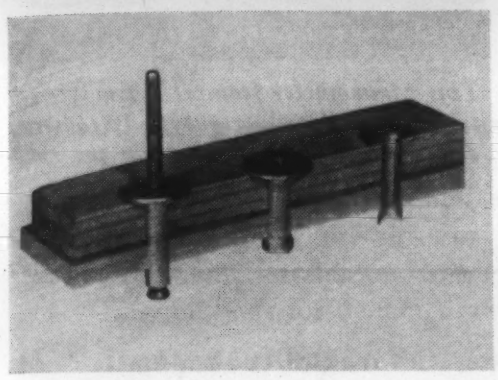
New Model GA Wasp direct current arc welders, available in 150- and 200-amp sizes, have been announced by *Air Reduction Sales Co.*, div. of *Air Reduction Co., Inc.*, 60 E. 42 St., New York 17.

Designed to further advance the efficient performance of the Wilson line, the volt ampere characteristics of these machines make them especially suited to d.c. straight polarity Heliwelding with Thor-Tung. Excellent commutation at all settings, plus the advantages of self-excitation and split-pole, cross-field design are said to provide good operation at all current settings.

Continuous overlap from each current range to the next provides a wide, unbroken range of welding current—30 to 250 on the 200-amp welder and 20 to 185 on the 150-amp machine.



This d.c. arc welder is available in 150- and 200-amp sizes.



Here the new rivet is shown before and after driving, along with a cut-away.

Blind Rivets Provide Increased Bearing Area

Huck Manufacturing Co., 2480 Bellevue Ave., Detroit 7, has added a low silhouette, large diameter head blind rivet to its line of permanent fasteners. These blind rivets, according to the company, provide an increased bearing area when fastening thin or soft materials to metal frameworks. The rivets are used for foil, plywood linings or floors, Masonite or Bristol board panels, insulation, etc.

The fasteners are available in both aluminum and steel in either the R949 (Pull Through) or R974 (Self Plugging) types in 1/8-, 3/16- and 1/4-in. dias.

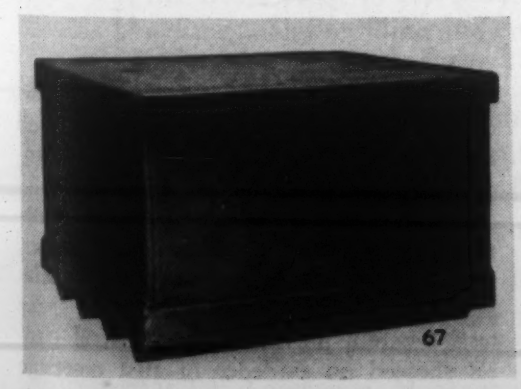
New Polyester Resins Withstand Temperatures to 500 F

American Cyanamid Co., 30 Rockefeller Plaza, New York 20, has announced the development of three new polyester resins that are said to withstand prolonged temperatures up to 500 F without losing strength. These new plastic resins are based on the company's newly developed triallyl cyanurate, a monomer which the company is at the present time making available to manufacturers for pilot plant use.

The new resins, reinforced by glass cloth, will give flexural strength values during exposure at 500 F of from 30,000 to 35,000 psi. They lose virtually none of their strength after more than 24 hr of continual exposure at this temperature. The best previously available heat resistant polyesters showed strengths of only 15,000 to 20,000 psi upon initial exposure to 500 F.

The resins will be marketed as PDL 7-669, a general purpose resin; PDL 7-680, a fire resistant (self-extinguishing) resin containing antimony trioxide; and PDL 7-679, a crystalline resin for impregnating mat or cloth.

These new resins are expected to find valuable applications as light weight, heat resistant airplane parts, as durable ovenwear for bakeries and the home, and other applications where plastics currently available cannot be used.



This carburizing box features V-type supporting skids.

Improved Carburizing Box Features V-Skid

The Stanwood Corp., Chicago 39, has incorporated V-type supporting skids for a popular type carburizing box. Users who have already tried these improved boxes on numerous applications report substantially better support for heavy loads under high temperature use. The new construction has also resulted in improved air circulation over the bottom of the box.

The sides of these boxes are rolled plate for extra strength, less weight, and more space for parts. Expansion and contraction, resulting from fluctuating temperatures, is uniform from top to bottom and is said to add many hours of service to the life of the boxes. An additional strength factor is achieved through the use of rounded rather than welded corners. All necessary welding is gas tight.

One-piece combination cast bottoms and legs are available for extra-heavy loading. Sizes are available for many applications.

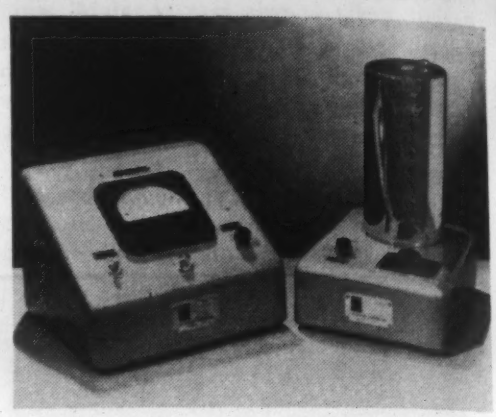
New Materials and Equipment continued

Gammometer Utilizes Newly Introduced Cell

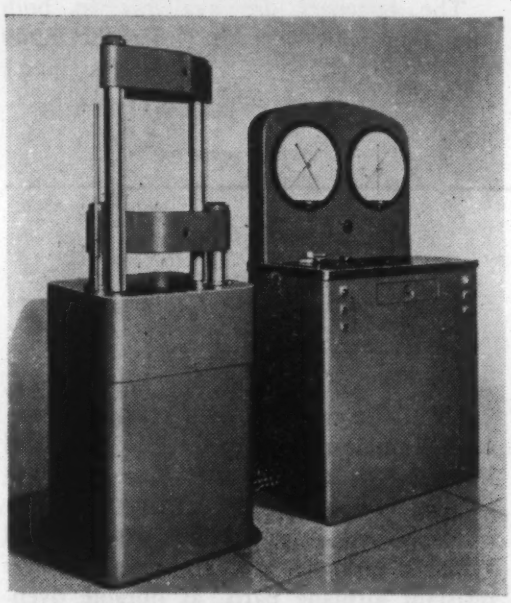
The Ohmart Corp., 2347 Ferguson Rd., Cincinnati 38, has announced the addition of the Model AH-1 Gammometer to their line of radiation measuring instruments. As in their other instruments, the new model utilizes the newly introduced, exclusive Ohmart Cell (in which radioactive energy is converted directly into electrical energy) as the radioactive element.

With the use of this cell, the need for a high voltage power supply is said to be entirely eliminated. The result is an instrument which is dependable and simple to operate. No longer is it necessary to operate and maintain complicated equipment. The cell is so designed that samples are placed in a well within the cell, resulting in maximum precision—since the quantities of activity measured are much larger than when slides must be prepared. The advantage of direct readings also contributes to increased accuracy.

With the introduction of the new instrument, the company now offers a line of Gammometers to meet a wide range of needs, with ranges from as low as 0.1 microcurie to 10,000 microcuries full scale, calibrated in terms of radium (standard), iodine-131, or cobalt-60. For measurement of ambient field intensity, the units are available calibrated in milliroentgen per hour from 0.1 to 10,000 mr/hr full scale. These and other instruments are finding many applications in scientific and laboratory work, in medicine for dosage preparation, in the following of chemical processes and liquid level measurement, and in the detection of radioactive contamination of public water supplies.



This gammometer features a new type cell in which radioactive energy is converted directly into electric energy as the radioactive element.



This improved, low-cost universal testing machine has a capacity of 120,000 *lb.*

Low-Cost Universal Testing Machine

An improved, low-cost universal testing machine of 120,000-lb capacity has been announced by *Baldwin-Lima-Hamilton Corp.*, Philadelphia 42. The new Model 120-H, like the 12-H announced earlier in 1951 and the 60-H, has many of the features of larger Baldwin testing machines. One is that the hydraulic loading unit is separate from the indicating and control unit, which isolates recoil from breaking test specimens and permits adjusting maximum or lazy hands with minimum drag.

High rigidity is provided in a two-column design with 15 in. of clear lateral space between columns. This gives easy access to test specimens and simplifies observations. Load (either in tension or compression) is applied upward by an integrated piston and elevating cage consisting of the table, two uprights and upper gripping head, all of which have a 6-in. power stroke. Loading speed can be varied infinitely between 0 and 2 in. per min.

Load indication is a function of the hydraulic pressure in the loading cylinder, which is a lapped ram construction without packing. Indicator dial is 16 in. in dia. Bourdon gages for the indicator are precision Emery type, with accuracy within 1% or one dial division, whichever is greater. A standard company recorder can be used with the machine if desired.

Vinyl Primer for Use on Rusted Steel Surfaces

The U. S. Stoneware Co., Akron, has announced the availability of a new vinyl primer, Tygorust, specifically developed for use on rusted steel surfaces without the necessity for previous preparation. Easily applied by brushing, spraying or dipping, the primer dries hard and can be overcoated in a matter of minutes. It is said to adhere tenaciously to rusted steel, damp or dry, and can be used with any type of finish coating—particularly vinyls.

Under exaggerated test conditions, Tygorust has been brushed and sprayed on damp rusted panels, and also brushed on dripping wet rusted panels, with completely satisfactory results. Dry, rusted steel has been successfully primed without even wire-brushing, according to the company. For maximum results, of course, the surface must be free of grease and oil, and loose scale should be removed.

Despite the fact that the primer is fast drying, it can be applied to old, oxidized paint films (bituminous coatings excepted) without lifting or bleeding and can be safely overcoated with vinyl, nitrocellulose, alkyd and oil-based finishes.

Indication of the adhesive and rust-inhibitive properties of the new primer, finish coated with Tygon paint, is available in the results of 120-hr salt spray tests wherein previously rusted steel panels showed no evidence of rust creepage along the scorings.

(More News on page 132)

Boltaron

PRESSURE FORMABLE SHEET

More than plastic! More than rubber! Boltaron (6100 Series) combines many of the advantages of both these versatile materials

Amazing Formability — Heat Boltaron sheet to approximately 300°F. Use low-cost molds of wood, metal, or composition — simple or complex shapes . . . low-pressure or vacuum forming equipment for shallow draws, simple plug and ring methods for deeper draws.

Tremendous Impact Resistance — A blow that will dent sheet metal or shatter metal castings will leave Boltaron unharmed. A Boltaron tote box can be dropped from a second-story window without injury.

Variety In Color, Size, and Thickness — Boltaron can be produced in any color or shade, and in mirror, matte, and grained finishes. Colors won't scrape off because they are an integral part of the Boltaron sheet. Boltaron is available in standard sheets of 32" x 62" and 35" x 72", in thickness from 1/32" to 1/2".

Thorough technical service on Boltaron is ready for your use at the Bolta Engineering Laboratories.

Service *and* More Service — Bolta's designing and engineering staff, backed by many years of experience in the plastics field, is ready to work with you!

A special fabricating laboratory is in operation at the Bolta plant in Lawrence, Mass., for your benefit. Special molding and cutting techniques have been developed.

All this engineering is available to you so that you can make the most efficient use of Boltaron. If you do not do your own fabricating, Bolta can give you the name of a qualified fabricator in your vicinity.

Let us answer your problem — Write today for illustrated brochure: Department 302, BOLTA, Lawrence, Massachusetts.

BOLTARON (6100 SERIES)

GENERAL SPECIFICATIONS OF STANDARD STOCKS

(Special BOLTARON available on request)

PROPERTY	Temp. °F.	Value	CHEMICAL RESISTANCE:	Temp. °F.	Value
Specific Gravity	70	1.10-1.20	Water Absorption (24 hr. immersion)	70	0.5
Rockwell Hardness "L"	70	28	10% Sulfuric Acid (7 days)	70	0.3
% Elongation at Rupture	70	40	3% Sulfuric Acid (7 days)	70	0.5
% Elongation at Maximum Tensile	70	3	10% Sodium Hydroxide	70	0.3
Ultimate Strength — Tension (p.s.i.)	70	4400	1% Sodium Hydroxide	70	0.5
Young's Modulus in Tension	70	250,000	95% Alcohol	70	3.3
Impact Strength (Izod)	70	15	Acetone	70	Soluble
(ft. lbs./in. notch)			Naptha	70	1.5
(ft. lbs./in. notch)	20	4	10% Nitric Acid	70	0.5
(ft. lbs./in. notch)	0	1	10% Hydrochloric Acid	70	0.2

Specifications will vary as pigmentation and surface finish is changed.

NEW! Boltaron 6200, a plastic of remarkable chemical resistance is available to you, exclusively through H. N. Hartwell & Son, 947 Park Square Bldg., Boston, Mass.

Boltaron

A BOLTA Plastic

Our Custom Molding Division specializes in injection and compression molding of all types. Write direct to this Division for full information

Another "have carlson do it"

Stainless Steel Order

Only a small part of the complete order for a special critical application is shown in the photo above.

Produced from Type 304 plate, these large sections (2⅜" x 11⅝" x 79⅞") were abrasive edge cut, the holes were rough machined.

Our customer, as so many others, depended on Carlson specialized cutting facilities to meet exacting specifications in minimum time and with no wastage.

Stainless steel plate items for critical application are being produced at G. O. Carlson, Inc. for all segments of the defense effort in record quantities.

Stainless steel is our only business . . . and we know it.

G. O. CARLSON, INC.

Stainless Steels Exclusively

200 Marshalton Road, Thorndale, Pa.

PLATES • FORGINGS • BILLETS • BARS • SHEETS (No. 1 Finish)

District Sales Offices and Warehouse Distributors in Principal Cities

New Materials and Equipment

Copper and Aluminum-Clad Laminated Plastics

Two well-known grades of Insurok laminated phenolic—T-725 and T-812—are now being offered as copper-clad and aluminum-clad sheets by the *Richardson Co.*, 2765 Lake St., Melrose Park, Ill.

According to the company, these metal-clad laminates can be printed and etched to produce printed circuits for use in radio, television and many other electrical assemblies. The metal foil is bonded to the laminate, under heat and pressure, and provides unusually high strength for this class of material. The electrical properties of Insurok are said to remain unimpaired.

Sheets are available in 36- by 42-in. sizes, in thickness from 1/32 to 3/32 in., inclusive. The nominal thicknesses of metal foils available from stock are 1½ and 3 mils. Sheets can be furnished with metal covering on one side or both sides, and certain special combinations, made to meet specific needs, are available on request.

Printed Resistors Provide Close Tolerance Reproduction

Printed resistors and resistance films of the carbon composition type, ranging in value from 25 ohms per sq in. to 1 megohm per sq in., are now being produced by semi-automatic methods at *Glass Products Co.*, 6911 S. Chicago Ave., Chicago 37. Wattage dissipation ratings of these resistors are from 1 to 5 watts per sq in. of film deposit, depending upon the heat conducting and operating temperature characteristics of the base material upon which they are printed.

Silver ink terminals are provided with these resistors, if desired; printed insulation is provided, where desired; and water repellent materials are incorporated into the insulation formulation.

According to the company, good aging properties are a characteristic of these resistors; a change of ±3% can be anticipated in one year's storage, and heat aging for 72 hr at 350 F produces changes under 2% of original value.

The company has made large production runs of printed resistors on phenolic laminate sheets in which 600 resistors were printed simultaneously on one sheet, and these were all held within ±10% of nominal value. The principal base materials used by the company are special paper-base phenolic laminates and glass and ceramics in special applications. Re-

In the New Unit Rig Drawworks Drum Clutch

MEEHANITE® CASTINGS MEAN DEPENDABILITY - QUALITY

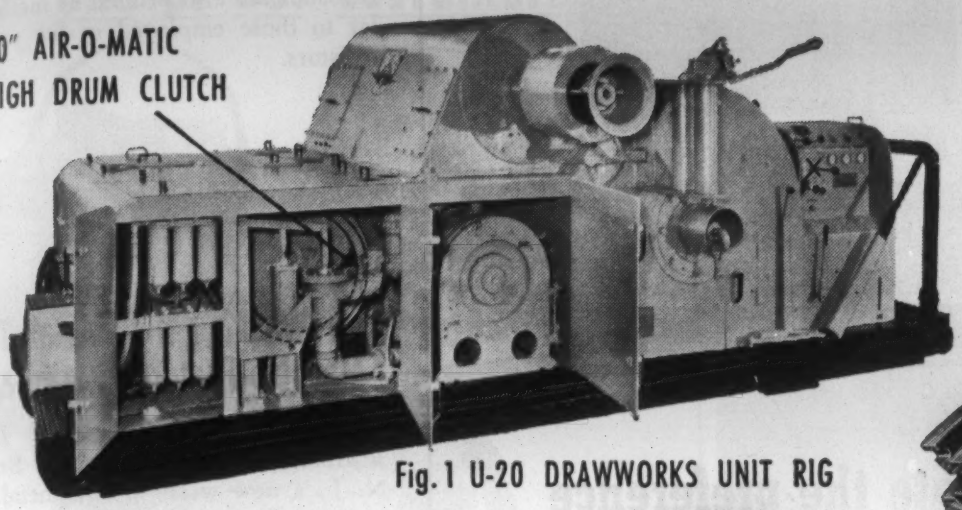
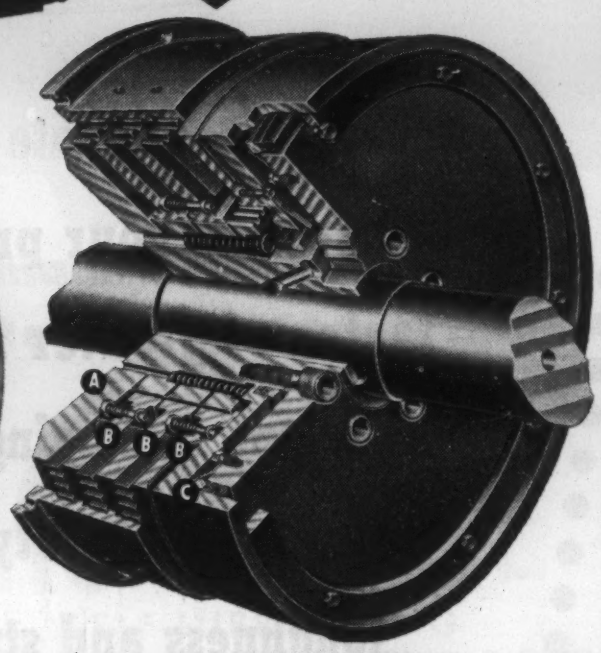


Fig. 1 U-20 DRAWWORKS UNIT RIG



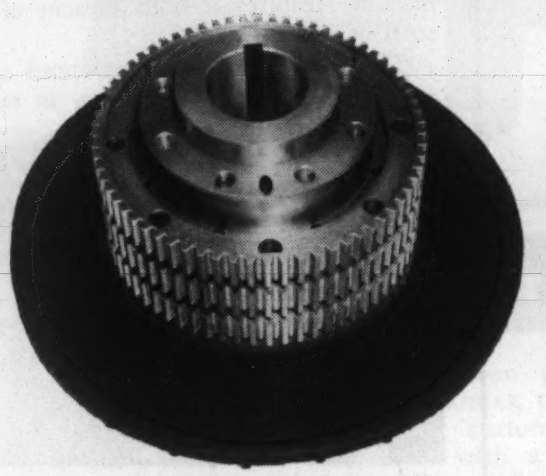


Fig. 2 HUB and BACK PLATE

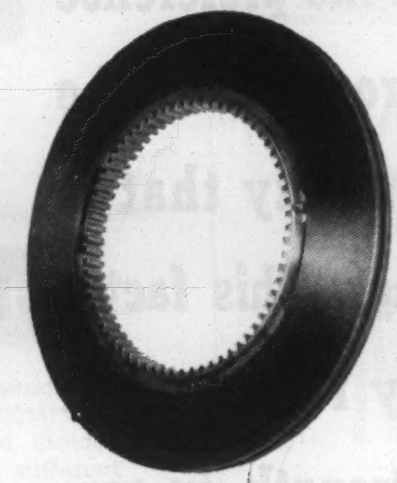


Fig. 3 FLOATING PLATE

Fig. 4 CLUTCH ASSEMBLY

The proof that in important new designs and improved products such as the U-20 Unit Rig (Fig. 1), manufactured by Unit Rig Company, Tulsa, Oklahoma, Meehanite castings are regularly meeting rigid specifications is quickly provided by this example.

A feature of the U-20 Rig is a 30-inch Air-O-Matic clutch vital to its smooth dependable operation. In this clutch the following Meehanite castings are specified:

1. **Hub and back plates (Fig. 2)**
2. **Floating plates (Fig. 3)**
3. **Pressure plate (Fig. 4)**

To these components Meehanite castings contribute high strength, good anti-friction properties, machinability and uniform high quality.

For proof that Meehanite castings can improve your product write for the Meehanite Handbook.

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
E. W. Bliss Co.	Hastings, Mich. and Canton, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Sonith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

MEEHANITE® NEW ROCHELLE, N. Y.

Engineering, production and economic advantages obtainable with forgings are presented in this Reference Book on forgings. Write for a copy.

Never underestimate the preference of users of your product for the factor of greater safety that is inherent in forgings. This factor of greater safety results from toughness and strength, in correct proportion, as found only in closed die forgings. Consult a forging engineer about the mechanical properties required for your product.

DROP FORGING ASSOCIATION
605 HANNA BLDG. • CLEVELAND 15, OHIO

Please send 60-page booklet entitled "Metal Quality — How Hot Working Improves Properties of Metal", 1949 Edition.

Name .....

Position .....

Company .....

Address .....

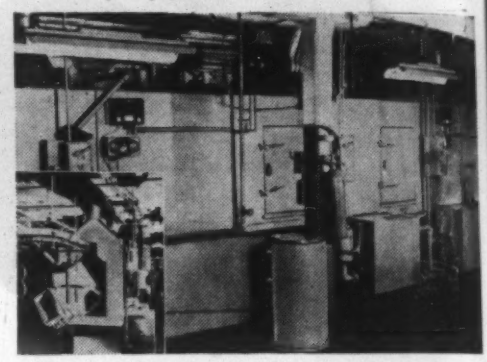
New Materials and Equipment

sistance elements for potentiometers and rheostats are also printed by methods similar to those employed in the printing of resistors.

New Washing and Metal Treating Machine Features High Capacity

Currently being offered by *Industrial Washing Machine Corp.*, New Brunswick, N. J., a new washing and metal treating machine features a high capacity of 36 sq ft of work per min.

The four operations performed automatically by the machine are, in order:



This washer features a high capacity of 36 sq ft of work per min.

phosphatize—clear water rinse—chromic acid bath—and drying. These are said to impart to the work an excellent surface for spray painting, resulting in a much longer painted life.

Other benefits claimed are the elimination of paint peeling and the reduction of paint-fault rejects.

Designated as Model OM 20 X 34-W-CWR-CAR-D, the machine measures 30 by 6 by 7 ft high and utilizes existing steam line for heating solutions.

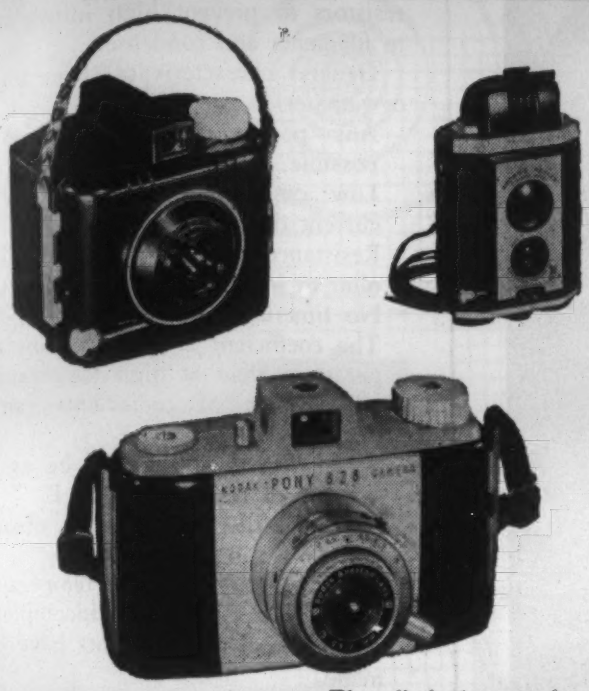
Temperature Sensitive Resistor Paints for Many Uses

Currently being offered by *Micro-Circuits Co.*, New Buffalo, Mich., as an economical solution to problems in control, measurement and compensation involving temperature, new temperature sensitive resistor paints are said to have wide possibilities in many types of circuits.

Some general uses for the paints are: temperature compensation; time-delay devices; temperature measurement and tem-

THIS RECORD SPEAKS FOR ITSELF

30 Years' Production of MOLDED PLASTICS for one of our customers!



Phenolic body parts by AUBURN

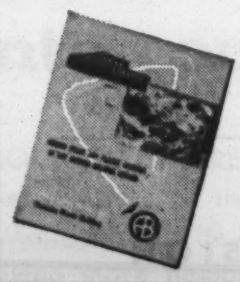
220 Different Parts

Ever since 1922 AUBURN has been producing molded plastics for the EASTMAN KODAK COMPANY. During this period 220 different custom molded parts have been delivered, each with a different engineering problem—each with a different solution—in compression molding, transfer molding, injection and extrusion.

In a field as highly competitive as molded plastics, performance such as this for one of America's foremost corporations speaks for itself. We feel that some of the reasons have included:

- **Versatility in producing parts that have met both volume and precision specifications in any plastic.**
- **Steady expansion of facilities and modernization of equipment.**
- **Research and organizational instruction to insure that standards of quality control are maintained.**
- **Consistent "on schedule" delivery.**
- **Ability to take the initiative in improving product design, reducing the cost to the customer.**

A dependable subcontractor, AUBURN molds any material by any modern molding method. Complete tool and die-making facilities are maintained. For the complete story of AUBURN, write for free booklet.



Auburn Button Works, Inc.

300 McMaster Street, Auburn, New York

Founded in 1876 Telephone 3-5320

How is this for

BEARING PERFORMANCE

- No lubrication required
- Minimize cold start drag
- Self polishing and lapping
- Resistance to high heat
- Require no maintenance
- Immune to most acids and corrosion

Cut maintenance costs...

Reduce shutdown time...

Increase production...

MORGANITE

SELF-LUBRICATING

CARBON BEARINGS

APPLICATION: Extensive—from food machinery and guided missiles, to household appliances and steel mill equipment.

DESIGN: Manufactured to specification to exactly meet your requirements. For inaccessible locations, sealed mechanisms and unusual operating conditions.

CHARACTERISTICS: Self-lubricating action is derived from the inherent nature of the material. Thus will not warp, contaminate or impart taste or odor. Unaffected by high temperatures.

ECONOMY: Morganite is self-polishing and self-lapping, eliminating costly finishing.

Call or write for recommendations on specific problems, or request illustrated literature. See our bulletin insert published in Sweets Product Design File for further details.

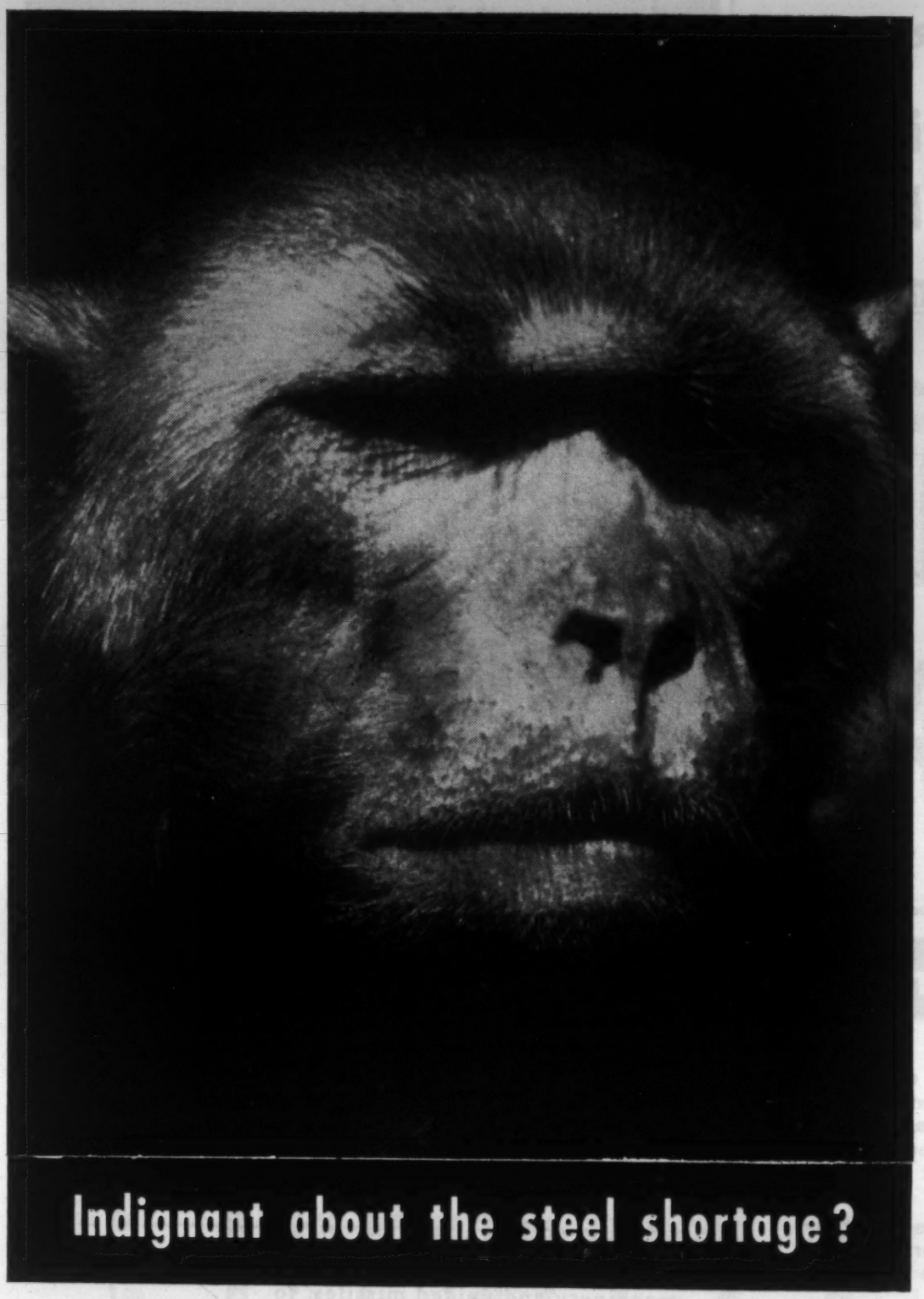
see our CATALOG in SWEET'S FILE for PRODUCT DESIGNERS

Morganite INCORPORATED

LONG ISLAND CITY 1, NEW YORK

TRADE MARK

Manufacturers of CARBON SPECIALTIES, MOTOR and GENERATOR BRUSHES and CARBON PILES


Indignant about the steel shortage?
SCRAPPY SAYS:
AID DEFENSE
MORE SCRAP TODAY...
MORE STEEL TOMORROW
Let us try to help you! In the supplies of steel that are available, we can often find a type of steel that will answer your particular purpose. Call one of our salesmen the next time you are faced with a steel supply problem. Our experience and resources may furnish your solution.
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UNITED STATES STEEL SUPPLY DIVISION
UNITED STATES STEEL COMPANY
HEADQUARTERS: 208 So. LA SALLE ST., CHICAGO 4, ILL. · WAREHOUSES COAST-TO-COAST
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UNITED STATES STEEL

New Materials and Equipment

perature control; direct control of large relays and small motors; and as series resistors to prevent high inrush currents to filaments and condensers.

General characteristics claimed for the new materials are:

Any power rating appears to be possible.

Low cost compared with cost of current devices.

Resistances from hundredths of an ohm to hundredths of megohms.

No time-lag observed to date.

The coefficient is larger at low temperatures than at high temperatures; wide range of coefficients can be made.

Resistance at 300 F can be as low as 1/30 of resistance at 70 F.

Best stability is currently obtained with lower resistance changes.

Very low and very high temperatures have been explored incompletely, but 500 and 600 F paints have been made.

Nickel-Free Electrode for Cast Iron

To meet the double problem of a widely increasing use of welding in the maintenance, repair and salvage of cast iron parts on the one hand, and an extremely critical shortage of nickel on the other, a new nickel-free electrode for cast iron, EutecTrode 27, has been announced by *Eutectic Welding Alloys Corp.*, Flushing, N. Y.

While the new rod does not replace nickel-bearing electrodes on all applications, it is said to offer an extremely high tensile weld with a uniform amount of carbon in the deposit so that the deposited material is similar to a high tensile, high carbon steel, thereby increasing the tensile strength of the weld.

Pocket-Size Tester for Nonferrous Surfaces

Peabody Industries, Inc., 12129 Hamilton Ave., Detroit 3, has perfected a new technique for testing surface hardness of nonferrous extrusions, castings, machined parts and fabrications.

First of its type to be manufactured in this country for the exclusive use of nonferrous material, this pocket-size surface hardness testing instrument weighs less

FREE. Send for illustrated 20-page mainspring guide to better product design and performance . . .

Sandsteel Spring Division — Sandvik Steel, Inc.
145 Hudson Street, New York 13, N. Y.

Gentlemen: Kindly send, without obligation, a copy of "Sandsteel Springs for Dual Power."

Name _____

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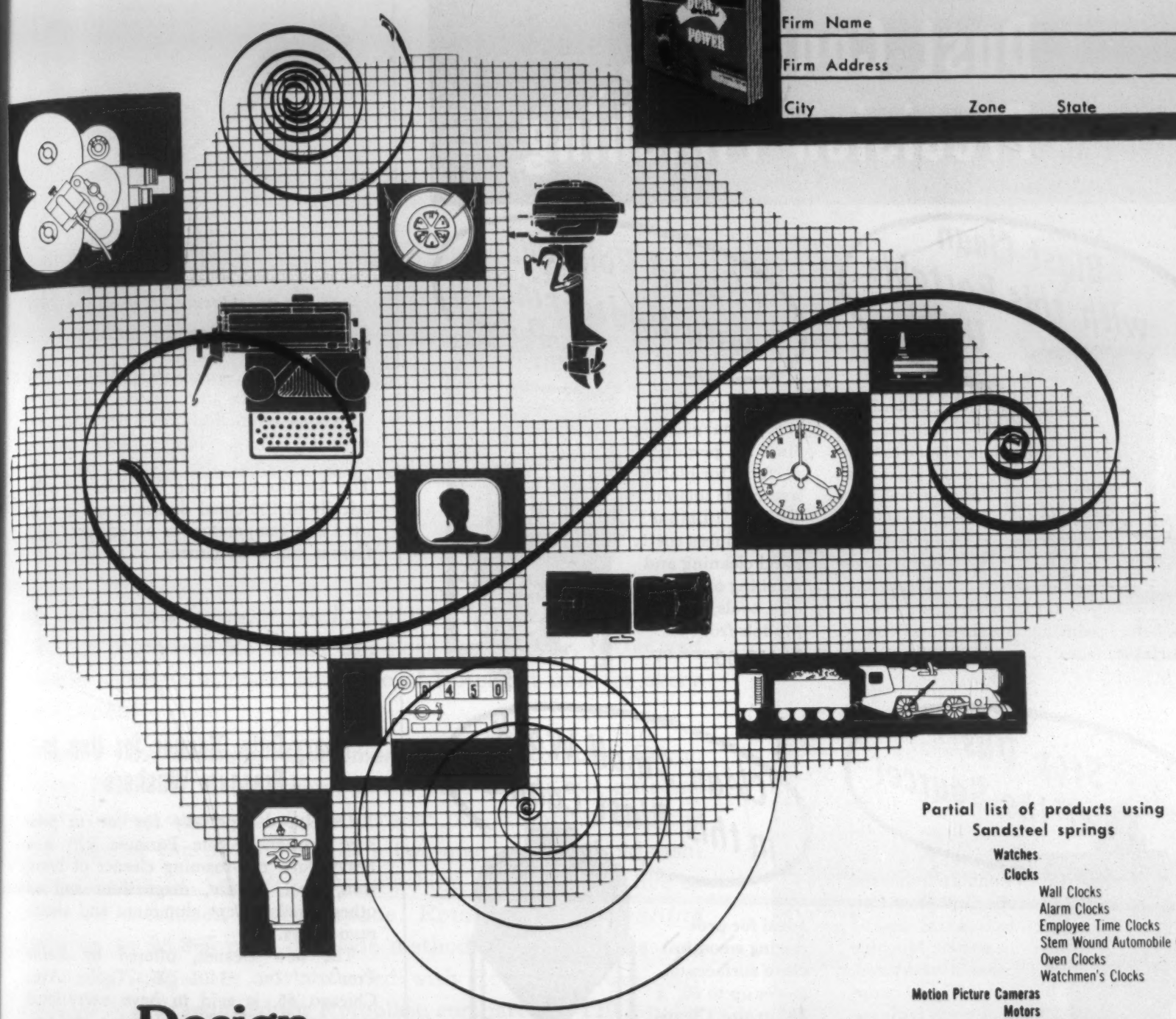

Design DUAL POWER into your product

DO YOU HAVE A PRODUCT THAT REQUIRES A FLAT SPRING? For superior design and performance of that product, inquire about Sandsteel CROSSCURVED Mainsprings. The crosscurving allows use of longer, thinner springs, giving more flexibility of design and a far more even delivery of energy. Take advantage of a quarter century of Sandsteel mainspring know-how, and consult us regarding your spring requirements. Write for informative brochure . . . without obligation.

Partial list of products using Sandsteel springs

- **Watches**
- **Clocks**
  - Wall Clocks
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  - Employee Time Clocks
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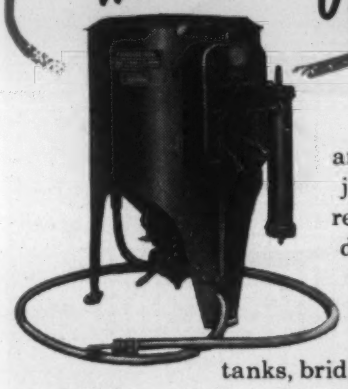
  - Oven Clocks
  - Watchmen's Clocks
- **Motion Picture Cameras**
- **Motors**
  - Outboard
  - Portable Saw
  - Power Lawn Mowers
- **Office Machines**
  - Calculators
  - Computers
  - Comptometers
  - Typewriters
- **Timing Devices**
  - Parking Meters
  - Switches for Washing Machines
  - Electric Time Switches
- **Instruments**
  - Tachometers
  - Altimeters
  - Gauges
  - Electric Meters
- **Recording Devices**
- **Earphones**
- **Eyeloupes**
- **Television Aerials**
- **Vending Machines**
- **Reels (return mechanism)**
- **Toys**

SANDSTEEL SPRING DIVISION—SANDVIK STEEL, INC.

General Offices and Main Plant: 145 Hudson Street, New York 13, New York

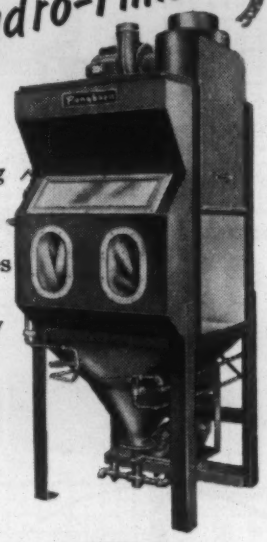
NOW! Pangborn Stock Units for Blast Cleaning... Dust Control... Precision Finishing

Blast Clean with this Portable Unit!



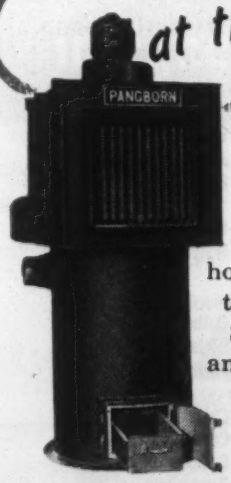
Ideal for maintenance and many other jobs, including removal of rust, dirt, scale, etc. Economically cleans large objects like tanks, bridges, structural work before painting. Six sizes, stationary or portable, from . . . . **$170.00** and up.

Speed Polishing with Hydro-Finish!



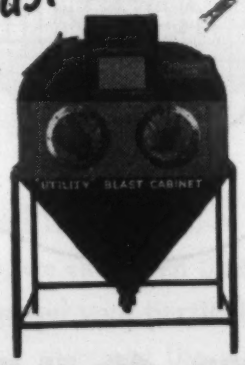
Removes scale and directional grinding lines . . . prepares surfaces for plating and holds tolerances to .0001"! Liquid blast reduces costly hand cleaning and finishing of molds, dies, tools, etc. Models from **$1410.00** and up.

Stop Dust at the Source!



Pangborn industrial type Unit Dust Collectors trap dust at source. Machine wear is minimized, housekeeping and maintenance costs reduced. Solves many grinding and polishing nuisances and material losses. Models from **$286.00** and up.

Clean Small Work in this Blast Cabinet!



Ideal for producing smooth, clean surfaces on pieces up to 60" x 36" in size. Cleans metal parts, removes rust, scale, dirt, grime, paint, etc., in a few seconds. Saves money all year 'round. Models from . . **$319.00** and up.

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment

Pangborn MAIL COUPON FOR DETAILS

Check for more information

- ☐ Blast Cleaning Cabinets
- ☐ Blast Cleaning Machines
- ☐ Unit Dust Collectors
- ☐ Hydro-Finish Cabinets

PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.

Gentlemen: Please send me more information on the equipment I've checked on the left. To be used for_____

Name . . . . . .

Company . . . . . .

Address . . . . . .

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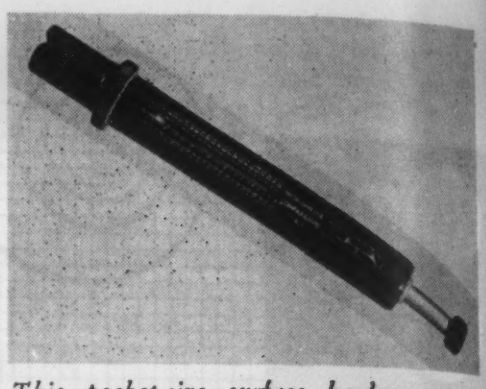
New Materials and Equipment



This pocket-size surface hardness tester opens a new approach to quality control.

than 5 oz. and measures under 5 in. in length.

Outstanding features include direct reading scales, one incorporated accurately correlated numerical equivalents of the Brinell 500-kg, 10-mm Ball Testing Equipment and the Metalometer scale. The Metalometer scale is graduated numerically in 100 equal divisions and is to be used as a comparator for all accepted nonferrous master specimens.

Heavy-Duty Cleaner for Use in Pressure Washers

Developed especially for use in pressure washers, Kelite Formula 973 is a heavy duty, non-foaming cleaner of brass, iron, steel, bronze, magnesium and all other metals except aluminum and aluminum alloys.

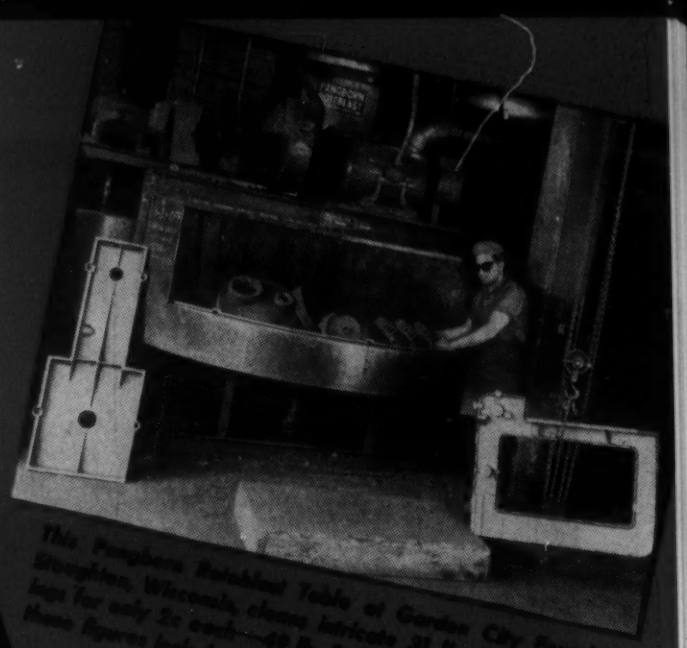
The new cleaner, offered by *Kelite Products, Inc.*, 3401 W. Touhy Ave., Chicago 45, is said to have exceptional penetration and oil emulsifying abilities. Its repression powers keep hard water scale from forming and will eventually remove old deposits already formed. Good rinsing properties are also said to be incorporated into the cleaner.

Fast-Drying Black Primer Has Good Adhesion

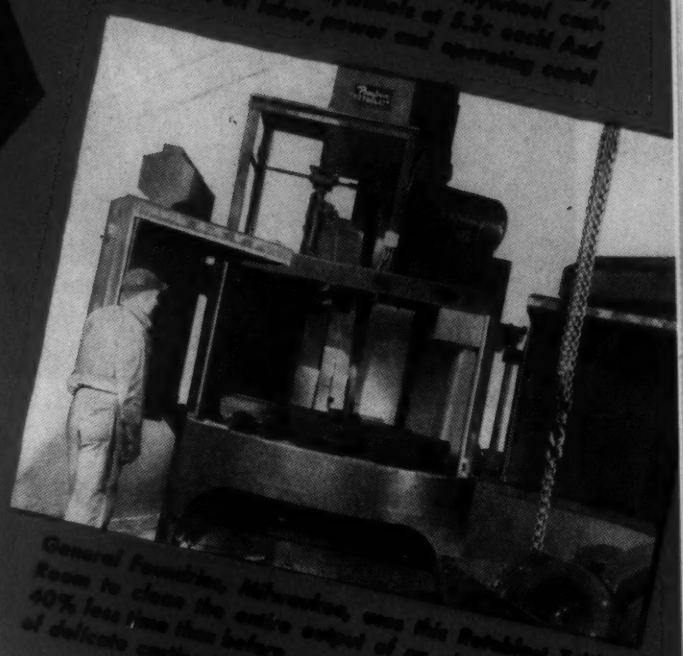
The United Lacquer Manufacturing Corp., 1001 W. Elizabeth Ave., Linden, N. J., has announced a new fast-drying black universal primer, which clings even to polished chromium, stainless steel, zinc or glass, establishing a base that anchors a protective coating. Without such a coat-

Experienced Foundrymen Know—

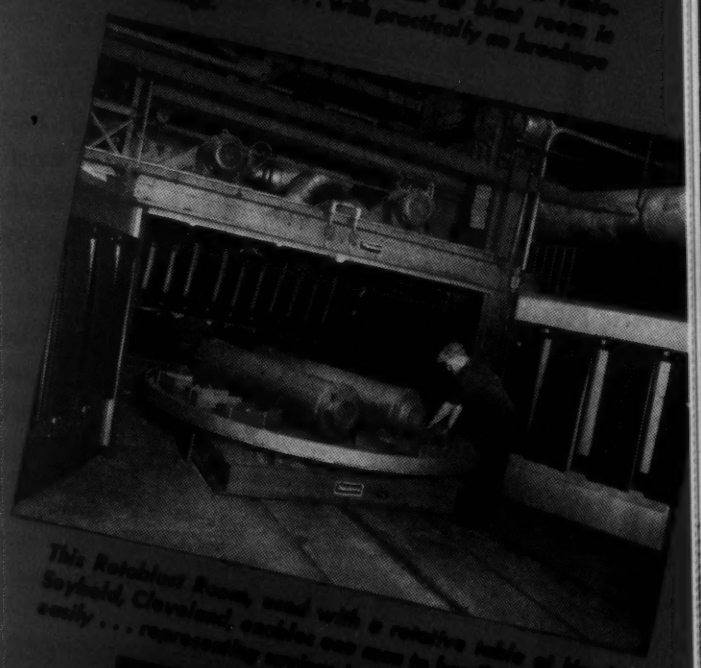
PANGBORN ROTOBLAST* speeds production!



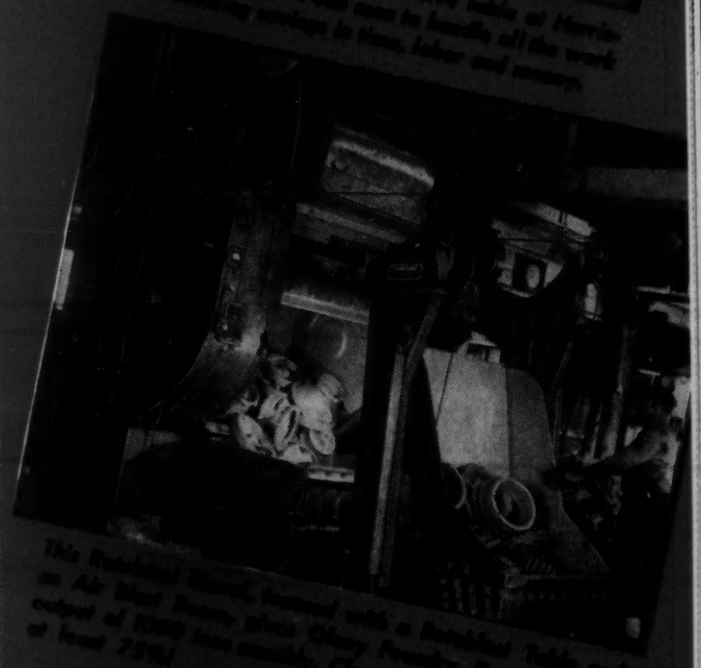
This Pangborn Rotoblast Table at Gordon City Foundry, Sheyboygan, Wisconsin, cleans barrels 31 in. Ryrobest crankcase for only 2c each—49 lb. Ryrobest at 2.5c each! And these figures include all labor, power and operating costs!



General Foundries, Milwaukee, uses this Rotoblast Table-Room to clean the entire output of an air blast room in 40% less time than before . . . with practically no breakage of delicate castings.



This Rotoblast Room, served with a rotative table at Harvin Seyhold, Cleveland, enables one man to handle all the work easily . . . representing savings in time, labor and money.



This Rotoblast Barrel, teamed with a Rotoblast Table and an Air Blast Room, gives Ohmy Foundry Co., Niles, an output of 1000 feet monthly. Cleaning time has been cut at least 75%!

No matter how large or small, heavy or light your castings, Pangborn Rotoblast can clean them faster, better and cheaper. There's a model and type of Rotoblast unit for every application!

Whether your cleaning requirements call for a Rotoblast Room, Table, Barrel or Table-Room, you'll save money five different ways: *Labor costs go down* because one Rotoblast machine and operator can do as much as a two-man crew and old-fashioned equipment. One Rotoblast machine often replaces five or more old machines, *saving space*. Rotoblast *cuts cleaning time* up to 95.8% over old-style methods. Cutting tools *last up to ⅔ longer* on work cleaned with Rotoblast. And *only 15 to 20 h.p.* is required for Rotoblast, compared to 120 h.p. for old-fashioned equipment.

Get the facts now on how Pangborn can *speed production* and *increase profits* for you. Write for free Bulletin No. 214 to: PANGBORN CORP., 1700 Pangborn Blvd., Hagerstown, Md.

OVER 28,000 PANGBORN MACHINES SERVING INDUSTRY

Look to Pangborn for the latest developments in Blast Cleaning and Dust Control equipment

*Trademark of the Pangborn Corporation

MEMBER FOUNDRY EQUIPMENT MANUFACTURERS ASSOCIATION FEMA

Pangborn

BLAST CLEANS CHEAPER

with the right equipment for every job

WITH

HITCHINER

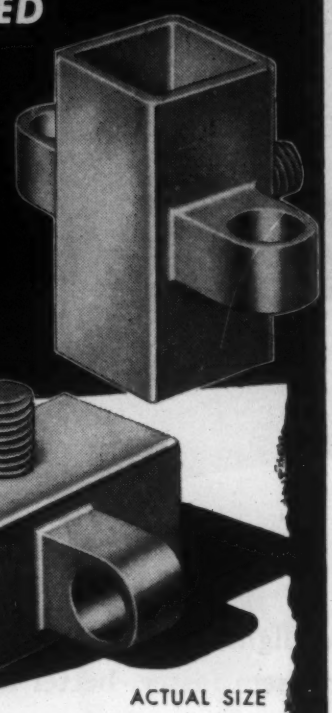
PRECISION INVESTMENT CASTINGS

COST IS REDUCED

QUALITY IS MAINTAINED

PLANT CAPACITY IS INCREASED

for G. L. Brownell, Inc., Worcester, Mass., manufacturer of gear driven twisting machinery for textile mills since 1881.



ACTUAL SIZE

"This company is always anxious to keep the quality of its product up but equally desirous to utilize any new techniques to keep the price of its product as low as possible.

The part shown above, known as a Traverse Head, for many years was machined from a bronze sand casting. Recently this part was changed to your precision investment casting in manganese bronze.

Two advantages have resulted. The cost of the piece has been reduced while maintaining the quality, and productive capacity of the Brownell shop has been increased due to removing this part from its production."

From a letter from Carl R. Brownell, President, G. L. Brownell, Inc.

Added to all these advantages is the improved appearance inherent in precision investment castings. Ask Hitchiner how to solve your investment casting problems.

Send your drawings for complete engineering analysis and recommendation.

To learn more about Hitchiner precision investment castings send for this free informative folder.

HITCHINER Manufacturing Company, Inc.

MILFORD 3, NEW HAMPSHIRE

Sales Office: 967 Farmington Ave., West Hartford 7, Ct. Representatives in principal cities.

New Materials and Equipment

ing, military instruments, devices and weapons tarnish and otherwise are rendered useless by atmospheric conditions.

This vinyl plastic-base primer, VB 282, is said to adhere well to brass, chromium, stainless steel, aluminum, zinc plating and molded phenolics. Its extreme flexibility allows parts to be formed, extruded or blanked after they are finished.

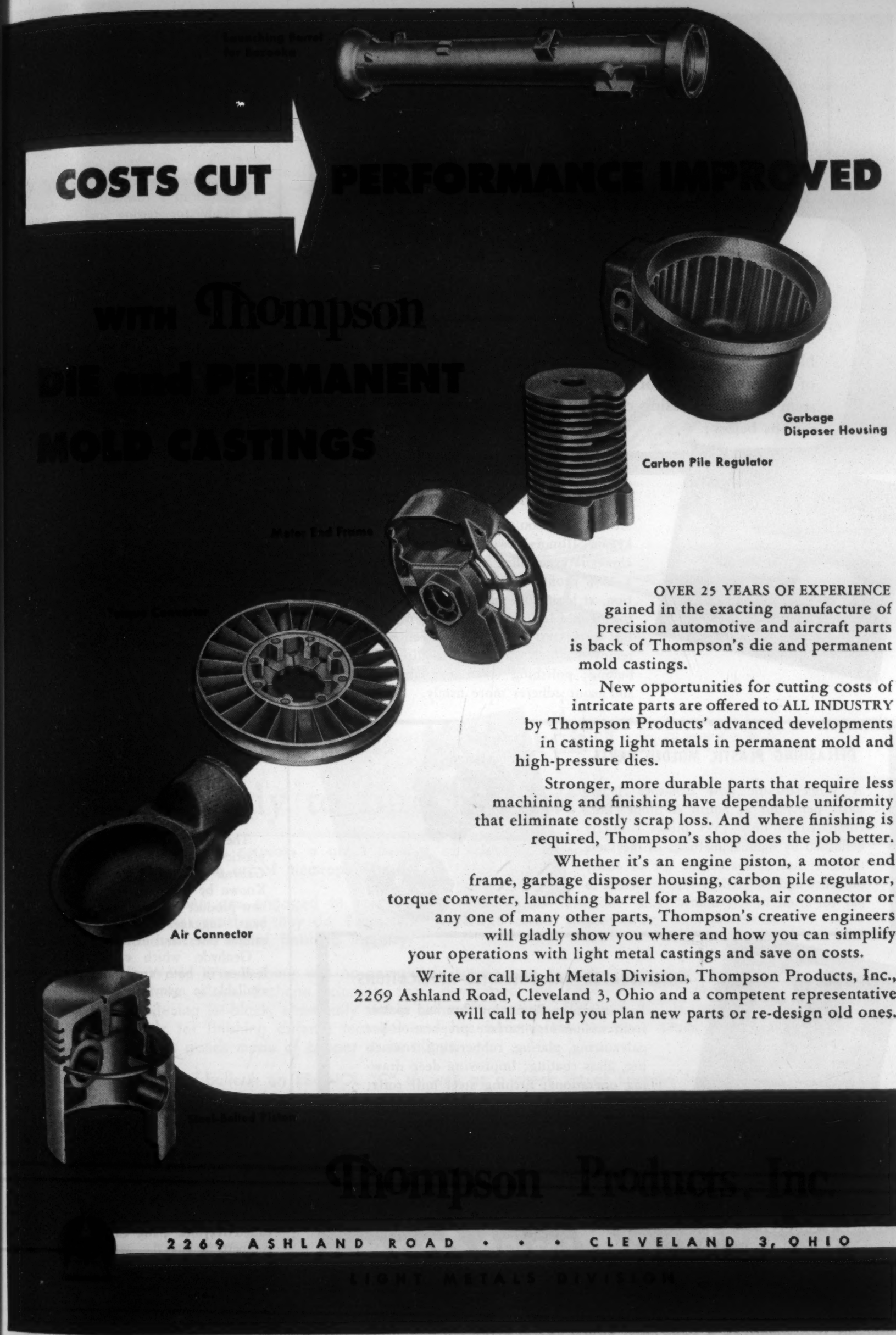
VB 282 dries in 15 min., thereby eliminating need for baking the primer coat, and making possible more productive use of a factory's finishing facilities. Other advantages claimed are: it can be applied by dipping or spraying, and it is resistant to salt spray, humidity, abrasion and solvents.

Testing Machine Performs Quick Compression and Crushing Tests

Accurate compression and crushing tests can now be made quickly and easily with a low-cost, light weight, portable hydraulic compression tester offered by *Labquip Corp.*, 4520 W. North Ave., Chicago 39. According to the company, the tester has been used with excellent results on metal, ceramic, wood and plastics parts; on paper boxes and other containers; and on soils, springs and similar materials. The machine can be employed on inspection lines and in industrial laboratories, and is an adaptation to industrial use of the apparatus widely used in the engineering soil testing field by government and military testing laboratories, colleges and universities and commercial and research testing laboratories.

In this machine the load is applied to the test specimen through a hydraulic sys-

This standard model tester has a capacity of 350 lb under an operating pressure of 100 psi, but machines with capacities up to 1000 lb can be supplied.



OVER 25 YEARS OF EXPERIENCE gained in the exacting manufacture of precision automotive and aircraft parts is back of Thompson's die and permanent mold castings.

New opportunities for cutting costs of intricate parts are offered to ALL INDUSTRY by Thompson Products' advanced developments in casting light metals in permanent mold and high-pressure dies.

Stronger, more durable parts that require less machining and finishing have dependable uniformity that eliminate costly scrap loss. And where finishing is required, Thompson's shop does the job better.

Whether it's an engine piston, a motor end frame, garbage disposer housing, carbon pile regulator, torque converter, launching barrel for a Bazooka, air connector or any one of many other parts, Thompson's creative engineers will gladly show you where and how you can simplify your operations with light metal castings and save on costs.

Write or call Light Metals Division, Thompson Products, Inc., 2269 Ashland Road, Cleveland 3, Ohio and a competent representative will call to help you plan new parts or re-design old ones.

Thompson Products Inc

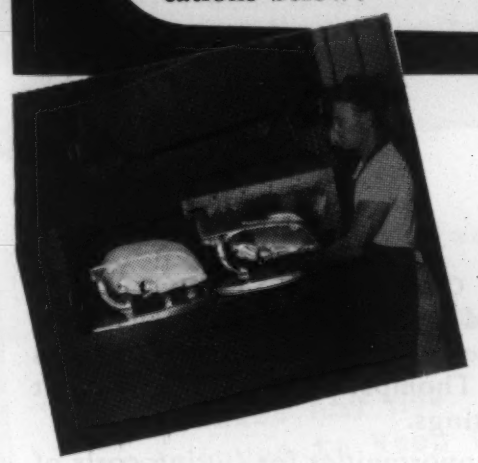
2269 ASHLAND ROAD • • • CLEVELAND 3, OHIO

LIGHT METALS DIVISION

WHEELABRATOR®
airless blast cleaning
IDEAS

.. to stem the tide of rising costs

There is no quicker or surer way to conserve manpower and cut the cost of finishing, cleaning and surface preparation than with a Wheelabrator. This versatile airless blast equipment performs these operations in a fraction of the time needed for other methods. It will help you stem the tide of rising costs, just as it has in the applications below:

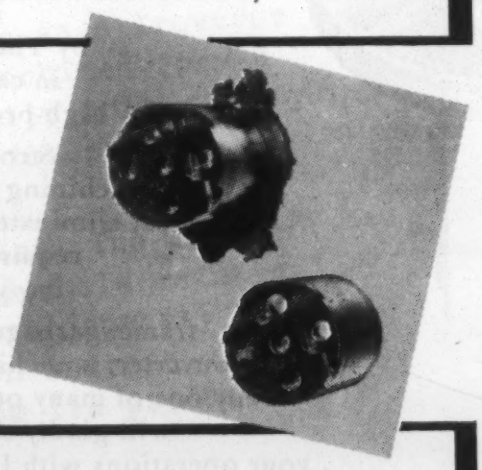


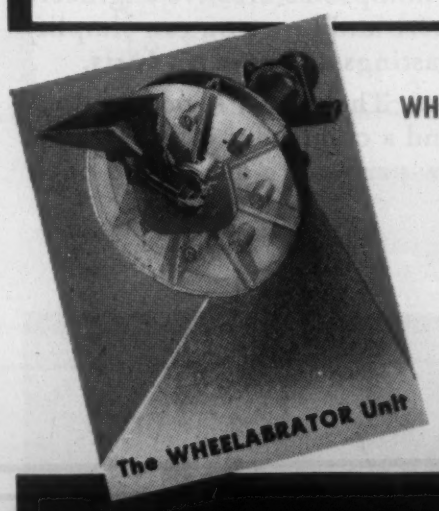
REDUCED POROSITY FOR DIE CASTINGS

At the Johnson Motor Division, Waukegan, Illinois, two Wheelabrator machines returned their entire cost and made a 25% profit . . . in one year. In addition, at least 40% of the porous castings that would have been "leakers" now pass the water test; minor imperfections are removed which previously required hand buffing; polishing takes less labor time and paint adheres more firmly.

DEFLASHING PLASTIC MOLDED PARTS

A Wheelabrator now deflashes 50,000 parts per hour at Smith & Stone, Ltd., compared to only 1333 pieces formerly deflashed by manual methods in the same time. It has decreased the use of costly broaches and effected savings sufficient to pay for itself in less than a year.





WHEELABRATOR HAS UNLIMITED APPLICATIONS

For example: Removing flux and spatter from weldments; Surface preparation for galvanizing, plating, rubberizing, enameling, glass coating; Improving deep drawing operations; Etching steel mill rolls; Removing mica from molded rubber; Cleaning castings and forgings to improve subsequent machining operations.

WORLD'S LARGEST BUILDERS OF AIRLESS BLAST EQUIPMENT

American
WHEELABRATOR & EQUIPMENT CORP.

AMERICAN WHEELABRATOR & EQUIPMENT CORP., 538 S. Byrkit St., Mishawaka, Ind.

New Materials and Equipment

tem actuated by compressed air. When connected to a convenient air source, it is ready for testing and no warm-up period is required. The load applied to the specimen is indicated on the dial of a double proving ring. This ring is used to obtain greater accuracy in the low range in tests which involve large loads, and to eliminate the necessity of changing rings for different tests. When the capacity of the more sensitive outer ring is reached, the heavier inside ring is brought into action. This method, therefore, permits taking advantage of the higher sensitivity of the outer ring without danger of overloading. The low range of the double proving ring is sensitive to loads of 0.1 lb.

The load applied to the specimen is indicated on the dial of the double proving ring. Complete stress-strain data can be obtained by reading the proving ring dial and the specimen strain dial at intervals during the test. An important feature is the ability to release the load instantaneously at any time during the test and thus keep the specimen intact for any measurements, photographs, drying or similar requirements.

Leather-Like Plastics Finding Many Uses

The development of a new leather-like plastic has just been announced by the *General Tire and Rubber Co.*, Akron. Known by the trade name, Genhyde, the new product will be used in making handbags, luggage, billfolds, camera cases, sample cases, and in novelty goods.

Genhyde, which c l o s e l y simulates leather in both appearance and feel is available in many colors.

Multiple Lock-Nut Fastener Offers Many Advantages

Kaynar Manufacturing Co., Inc., 820 E. 16th St., Los Angeles, has announced a completely new multiple lock-nut fastener, called Kaylock Gang Channel. Of small, compact design, the new fastener is said to be interchangeable with the standard type of anchor nut.

Made of 24ST Alclad aluminum alloy to Army and Navy Air Force Specifications, the channel portion features a

ENTHONE Research Chemists

are ready to find a solution

Enthone, Inc., employs a great number of scientists, research technicians and men skilled in the art of electroplating.

These men are engaged in fundamental research to find out why solutions and processes react as they do. From this knowledge come improved or new processes to assist the metal finishing industry.

In World War II there was no completely satisfactory process for blackening copper and its alloys. Enthone scientists then developed the EBONOL* "C" process for producing jet-black, chemically stable adherent coatings. EBONOL "C" is used extensively for finishing defense materiel and has become the standard black finish for civilian goods made of copper or its alloys.

Write for bulletin on EBONOL "C" as well as a check list of Enthone literature on over sixty products and processes for better electroplating and metal finishing.

U. S. PATENT NOS. 2,364,993, 2,460,896, 2,460,898, 2,481,854.

METAL FINISHING PROCESSES

ELECTROPLATING CHEMICALS

ENTHONE
INCORPORATED
442 ELM STREET
NEW HAVEN, CONNECTICUT

*Reg. Trade Mark

Wherever it's HOT specify Sicon

NEW IMPROVED SILICONE-BASE HEAT-RESISTANT FINISH

Protects Stewart Warner's New Saf-Aire Wall Furnace

Quality finish specifications for this heating unit called for a coating that would stand 500° and still retain its color and gloss—a temperature far above that incurred in normal operation. Ordinary heat resistant coatings failed. SICON *Ivory* and SICON *Beige* worked perfectly...just as SICON has solved so many other finish problems. *Write for dynamic proof of SICON'S amazing stability under heat! New Brochure now ready.*

Sicon

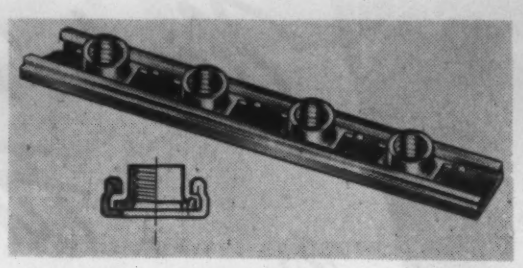
Silicone-Base Finish is manufactured exclusively by

MIDLAND INDUSTRIAL FINISHES CO.

Waukegan, Illinois

ENAMELS · SYNTHETICS
LACQUERS · VARNISHES

New Materials and Equipment



This multiple lock-nut fastener is said to be narrower, lower, lighter and stronger than any similar product ever produced.

double-vertical wall, providing high "push out" resistance, plus maximum rigidity, thereby requiring less riveting for attaching. Its small nut size allows closer center-to-center spacing than ever before possible, and as it is claimed to be as narrow as a standard AN-366 anchor nut, it is possible to install this time and weight saving product wherever standard anchor nuts were used.

The inserts used are the Kaylock spring steel high temperature self-locking nuts which are said to never wear out and weigh less than half the weight of most other self-locking high strength nuts. They are reported to be stronger than any bolt, to have high locking resilience, and to be impossible to damage by cross threading.

Currently made in sizes ranging from 8-32 through ¼ in.-28 size, the fastener is obtainable in either regular hole spacing or to any special hole pattern.

Stripping Oil for Tin and Terne Plating

A new oil stripping medium developed by *Archer-Daniels-Midland Co.*, 600 Roanoke Bldg., Minneapolis 2, is said to offer important economies and improved results in the hot dip tin and terne plating industries. In contrast to palm oil and other traditional stripping oils which gradually decompose and increase in body and viscosity under high temperatures, the new material is said to be so stable that decomposition is negligible. After a continuous six months' test, it still retained all the original properties required of a satisfactory stripping oil. No additions were necessary except to replace the oil carried away as film on the finished product.

According to the company, tin plate made with the new medium has shown better enamel adhesion than obtained with the use of palm oil or other fatty triglycerides commonly used.

Stability of the new oil is brought about by mixing a highly saturated, normally solid hydrogenated fatty glycerides

NOTCH-COIL RINGS UP SILVER BRAZING 800%

Stress-relieved notch-coil preforms snap off coil, snap snugly around refrigerator gas strainers in one time-saving motion.

STRESS RELIEVED notch-coil rings allowed automatic brazing of noxious gas strainers, raising rate from 60 to 480 per hour . . . costs slid from $3 to 80 cents . . . rejects were cut 95%. *Stress-relieved* rings assured a gas-tight bond under all conditions and eliminated the poor fill, spillage and costly alloy waste of previously used ordinary rings. Notch-coil eliminated tangling, distortion, breakage and sped up handling. Rings are *job-engineered to fit your needs* in *any* thickness and diameter in *butt, lap or gap* design. *Stress-relieved, notch-coil* rings are made from *Silfos* and *Easy-Flo wire.*

Machine-wound rings distorted when heat was applied, causing poor bond and spillage. Wide separation of ends prevented achieving required fill for a strong, gas-tight joint. Brazing costs with this method were prohibitively high.

Stress-relieved preforms maintain —.001-inch tolerence throughout heating cycle, requiring minimum amount of alloy. Leakage dropped to less than .5%. Solder flows evenly into joint for complete fill, eliminating spillage and waste.

LUCAS-MILHAUPT ENGINEERING COMPANY

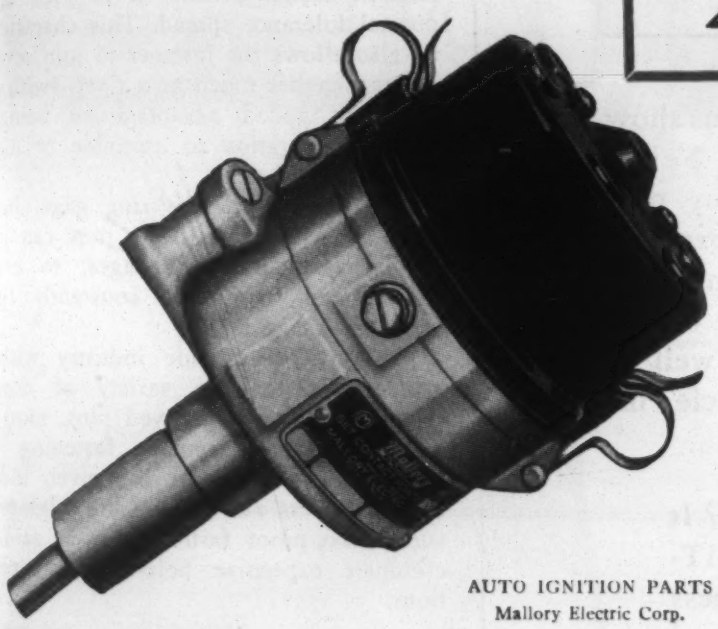
5055 S. LAKE DRIVE, CUDAHY, WIS.

Suburb of Milwaukee

Figure on PHENOLICS to keep "juice" on the job

CABLE JACKET
Picker X-Ray Corp.

POWER TIMING LIGHT
Sun Electric Corp.



AUTO IGNITION PARTS
Mallory Electric Corp.

TRANSFORMER
SWITCH FRAME
McDonald Mfg. Co.

...plan to use custom-molded DUREZ

Designing the properties you want into electrical and electronic products is in part a matter of selecting the right electrical-grade Durez plastic. Good judgment at this point can be expected to pay off automatically in cost economies, product performance, and profit.

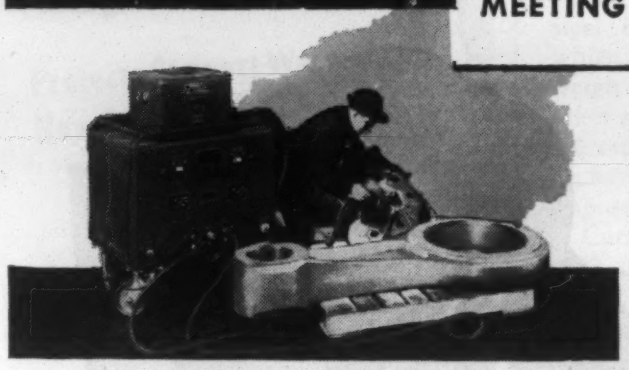
Being phenolics, these plastics possess the toughness, dimensional stability, lustrous finish, and resistance to heat, oil, and moisture required in numerous forms of electrical service.

These phenolics are mineral-filled. They have been developed by Durez especially for these services, with specific electrical properties that will meet modern industrial requirements. Dielectric strength of these compounds is as high as 450 (V/M-ST), and power factor as low as .02 (1 kc. conditioned 48 hrs. at 50°C.)

The electrical types are among the more than 300 Durez molding compounds that offer you the right properties in the right degree for your product. Your custom molder can help you apply them. His knowledge and equipment are of value in holding down costs at numerous steps from blueprint to assembly and shipping. Technical counsel is readily available through the Durez field staff.

Our monthly "Durez Plastics News" will keep you informed on industry's uses of Durez. Ask us to send a copy regularly. Durez Plastics & Chemicals, Inc., 1403 Walck Road, North Tonawanda, N. Y.

PHENOLIC PLASTICS THAT FIT THE JOB



These illustrations show examinations being made on quantity produced and short run orders. Examinations may be made by wet or dry method, as well as Magnaglo particle inspection.

How extensively is this tool used by UNITCAST? It is used to determine, improve, and to maintain UNITCAST STANDARD OF QUALITY. Casting soundness is a prime requisite at UNITCAST. Magnaflux is used extensively here, as a spot check, even though customer specifications do not include the use of this additional quality control factor. Why not let your problems become ours to control.

UNITCAST
Corporation
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends. Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio. *In Canada:* Canadian-Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

New Materials and Equipment

of iodine number not above 60 with an ester obtained from a higher monohydric aliphatic alcohol with a higher fatty acid. The ester can be used in proportions of 10 to 35%, depending upon the properties desired for the particular operation.

Metal Fastener Conforms to Holes of Varying Diameters

Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J., has announced an all-purpose, pressed fit metal fastener which is said to have a capacity to conform to holes of varying diameters because quick recovery inherent in the Rollpin design permits it to pick up a normal tolerance spread. This characteristic also allows the fastener to join several pieces together much as a rivet—with the important added advantage of being a one-man operation to assemble or disassemble.

The Rollpin, in the ring gage, holds tight against the walls. It thus can pick up backlash, as in linkages, to avoid chatter and to give a constantly tight series of linkages.

Designed to provide industry with a replacement for the variety of dowel, pivot, tapered and grooved pins, most of which require secondary fastening devices, the new fastener has given industrial engineers and designers a high-pressure, shake-proof fastener that is said to eliminate expensive hole-reaming operations.

Higher Production Possible with Four-Point, Double-Action Toggle Presses

A new series of four-point, double-action, toggle-drawing presses, said to feature quick advance and return speeds and good accessibility for maintenance purposes, has been developed by *E. W. Bliss Co.,* Canton, Ohio. The new presses are specially designed to meet the needs of the automotive and allied industries by making possible higher production rates for large-area drawn stampings.

Greater production rates have been made possible through use of the Eddy Current Clutch, which provides for quick approach to the work, slow-down to give proper drawing speeds, and quick return

Why G-E rubber-phenolics mean greater serviceability

Automatic dishwasher impeller and silverware basket molded from shock-resistant G-E rubber-phenolics.

Why was a General Electric rubber-phenolic compound selected to mold these automatic dishwasher parts?

The G-E rubber-phenolic silverware basket has the required strength and resilience to withstand the continuous impact of dropped utensils and vibration of the operating dishwasher. In this case, rubber-phenolics eliminated dependence on brass and provided a lower-cost, more attractive part with longer service life.

Actual tests show that the impeller, molded from G-E rubber-phenolics, has five times the shock resistance of the conventional phenolics previously used—thus minimizing replacement problems. Such tests also indicate that the rubber-phenolic impeller retains strength properties after continuous exposure to hot water and detergents.

DESIGNERS!

Specify G-E rubber-phenolics where greater serviceability at minimum cost is required.

MOLDERS!

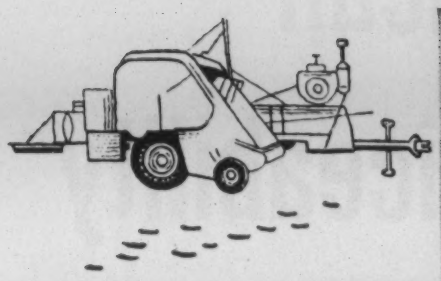
G-E rubber-phenolics may reduce your finishing costs, satisfy your customers, open new markets for plastics.

FOR COMPLETE DETAILS, just write to General Electric Company, Section H-1, Chemical Division, Pittsfield, Massachusetts.

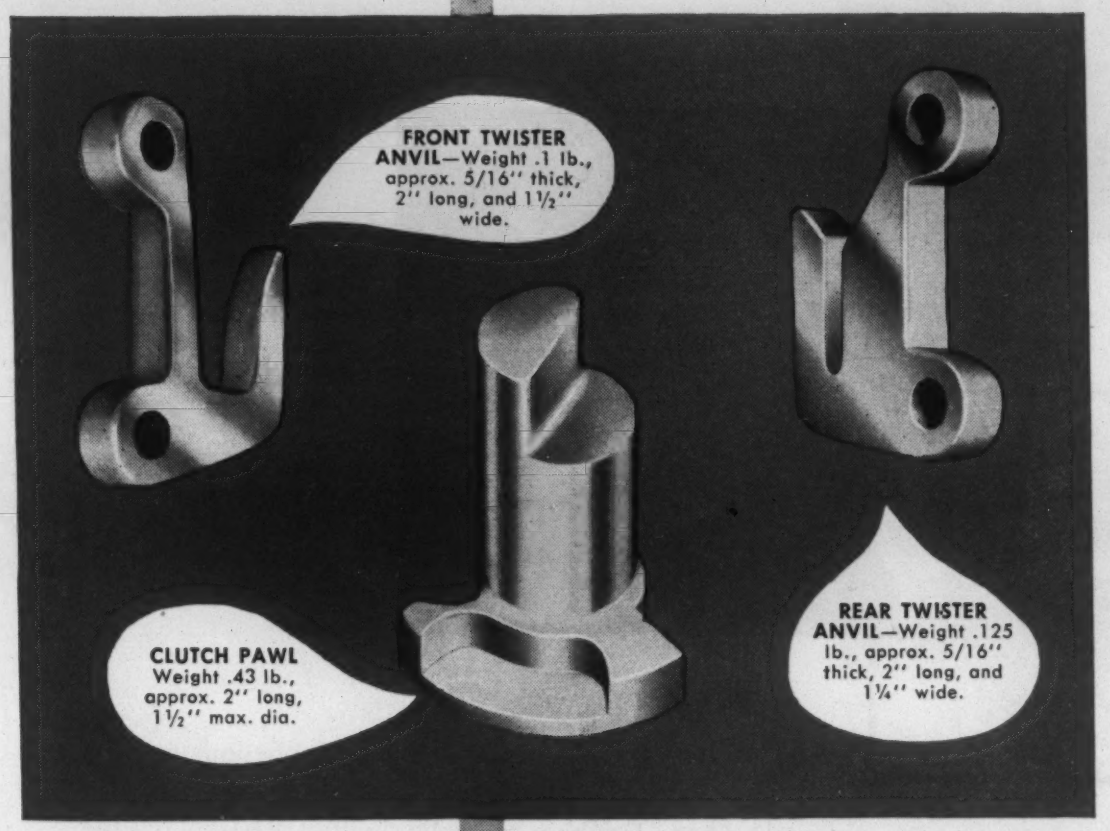
You can put your confidence in—

GENERAL ELECTRIC

Microcast®...



CUTS MACHINING COSTS ON NEW FARM BALER


FRONT TWISTER ANVIL—Weight .1 lb., approx. 5/16" thick, 2" long, and 1½" wide.
CLUTCH PAWL Weight .43 lb., approx. 2" long, 1½" max. dia.
REAR TWISTER ANVIL—Weight .125 lb., approx. 5/16" thick, 2" long, and 1¼" wide.

READY TO USE

The three Microcast parts shown above are being used virtually as cast, with only a finish grinding operation required for completion. Made from AISI 4615 carburizing grade steel, they are smooth, dimensionally uniform, and structurally sound as cast.

●

MICROCAST is the precision process originated by Austenal Laboratories, Inc., for the production of castings of intricate design using the high melting point alloys where surface smoothness and dimensional uniformity are mandatory, requiring little or no machining.

Precision Castings Lower Cost

To effect considerable savings in machining costs on their new Automatic Wire-Tying Baler, Pennsylvania's New Holland Machine Company wisely chose Microcast parts for three vital components. Also contributing to those savings was the complete development engineering assistance rendered by our Microcast Division, a skill developed through almost 25 years of pioneering in precision castings.

Perhaps you have a similar problem coming up . . . why not get full Microcast information today?

MICROCAST PRECISION CASTINGS PROCESS

MICROCAST DIVISION
AUSTENAL LABORATORIES, INC.
224 East 39th St., New York 16, New York
715 East 69th Place, Chicago 37, Illinois

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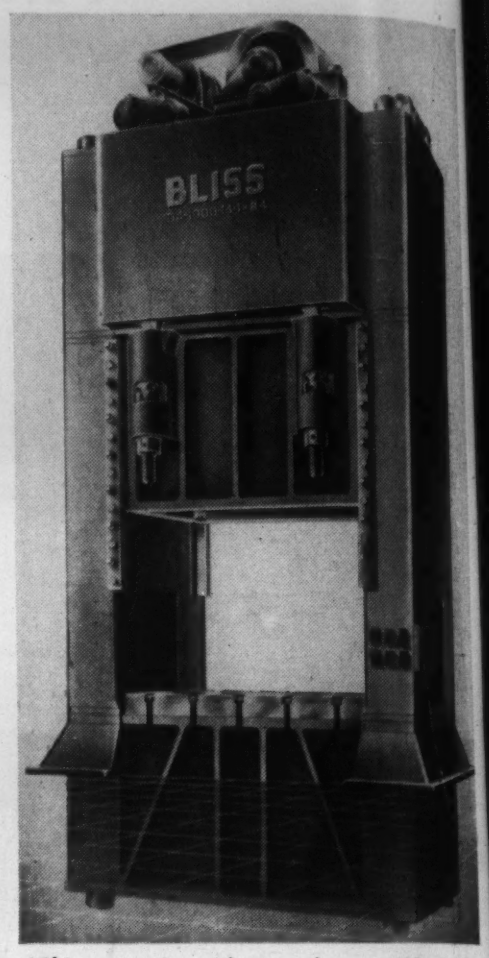
Write for fully illustrated literature describing the Microcast Process. Technical information, case histories, savings. No obligation. Get yours today!
Visit our Booth No. 552 ASTE Show Chicago Mar. 17-21

MICROCAST

MICROCAST TRADE MARK REG. U. S. PAT. OFF.

New Materials and Equipment



This press is said to make possible higher production rates for large-area drawn stampings.

speed to the top of the stroke. Even with comparatively slow drawing speeds, a rapid press cycle is said to be possible. The slow-down is accomplished by controlled slippage of the Eddy Current Drive Clutch through limit switches, which can be adjusted to vary the speed of any portion of the draw cycle.

There are three substantial cross-members in the crown which contains four totally enclosed gears with integral eccentrics for operating the plunger slide. Crown sections beneath the gears form a rigid tie member for the front, center and back transvertical sections. All gearing and toggle bearings inside the crown are lubricated by a cascade oil system.

Provision has been made for pneumatic die cushions in the bed, or the bed can be fitted with a synchronized third motion if required.

New Insulating Varnish Has Flexible Baking Cycle

Insul-Film, a new insulating varnish with the advantages of the silicones, but less expensive, has been developed by the *Electrofilm Corp.*, 7116 Laurel Canyon Blvd., North Hollywood, Calif. According

Van Huffel
cold-formed metal shapes
and tubing are basic
in better

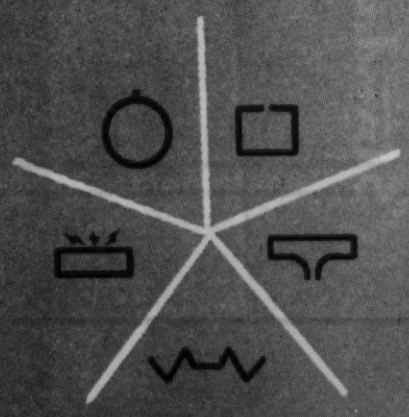
building construction

Whether hidden from sight doing a functional job or exposed to view just looking pretty, you'll find Van Huffel serving modern building construction needs in practically every nook and corner.

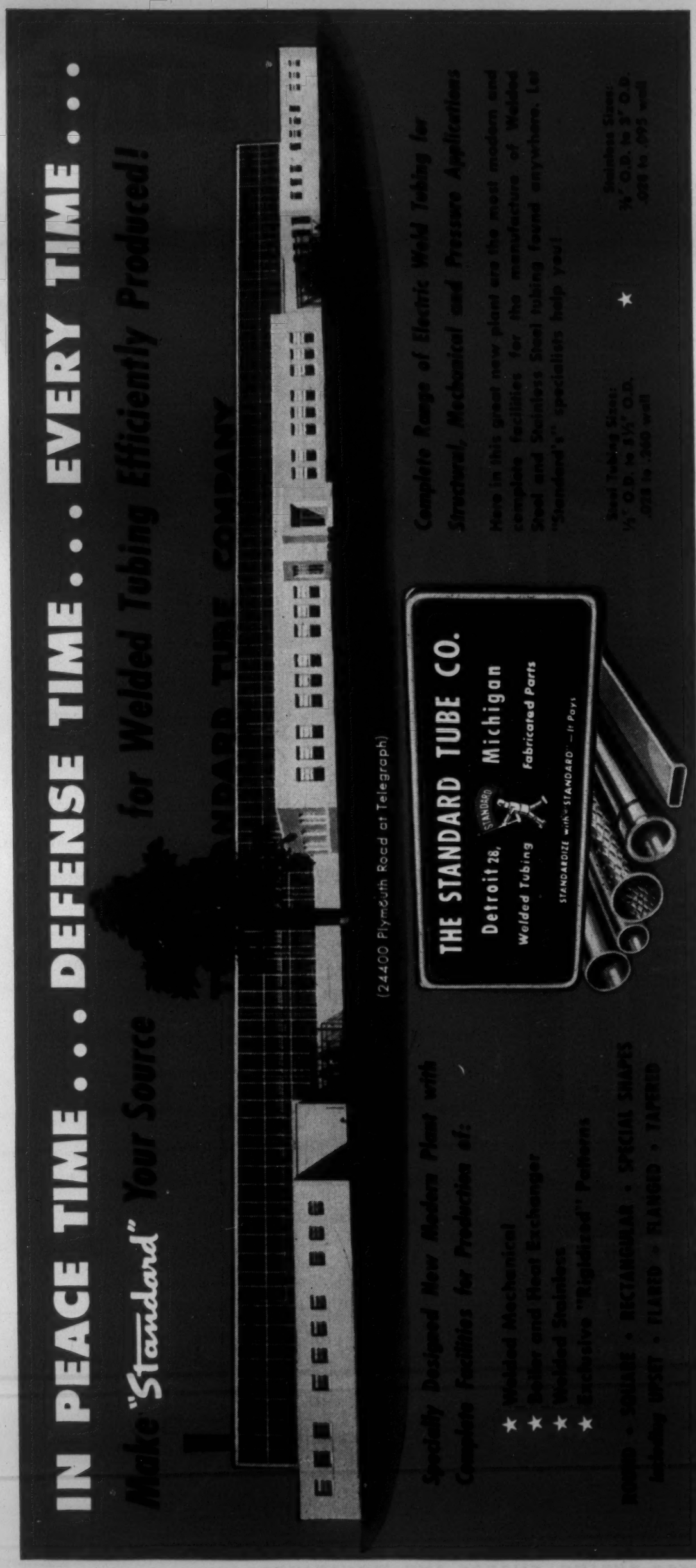
Architects, designers and engineers, knowing the structural advantages and versatility of Van Huffel metal shapes and tubing applications, are continually thinking up new uses. Wherever strength without excessive weight . . . beauty without complicated assembly are necessary characteristics, Van Huffel is basic in better building construction.

VAN HUFFEL

TUBE CORPORATION • WARREN, OHIO



WELDED, LOCK SEAM, OPEN SEAM, BUTTED TUBING, SHAPES AND MOULDINGS


IN PEACE TIME . . . DEFENSE TIME . . . EVERY TIME . . .
Make "Standard" Your Source for Welded Tubing Efficiently Produced!
STANDARD TUBE COMPANY
(24400 Plymouth Road at Telegraph)
Complete Range of Electric Weld Tubing for Structural, Mechanical and Pressure Applications
Here in this great new plant are the most modern and complete facilities for the manufacture of Welded Steel and Stainless Steel tubing found anywhere. Let "Standard's" specialists help you!
Steel Tubing Sizes: ½" O.D. to 5" O.D. .035 to .360 wall
Stainless Sizes: ¾" O.D. to 5" O.D. .035 to .095 wall
THE STANDARD TUBE CO.
Detroit 28, Michigan
Welded Tubing Fabricated Parts
STANDARDIZE with "STANDARD" — It Pays
Specially Designed New Modern Plant with Complete Facilities for Production of:
Welded Mechanical
Boiler and Heat Exchanger
Welded Stainless
Exclusive "Rightized" Patterns
ROUND • SQUARE • RECTANGULAR • SPECIAL SHAPES
BUTT • FLUSH • FLARED • FLANGED • TAPERED

New Materials and Equipment

to the company, the new varnish has many application advantages over other type insulations. It has excellent solvent, abrasion and insulation resistance, possesses good adhesion, and withstands severe vibration or shock. The new material also has the advantage of a flexible baking cycle, 300 to 400 F for approximately 1 hr, and can be sprayed, brushed or dipped.

Insul-Film is recommended for temperatures up to 400 F. Cost is $16 per gal.

Multiple Screw Extruders Compound, Extrude, Color and Pelletize

The *F. J. Stokes Machine Co.*, Philadelphia 20, has announced a new line of Stokes-Windsor multiple-screw extruders which are said to be an important step forward in the development of a complete line of equipment for every plastics molding requirement. Typical of the products more generally made on these machines are: tapes; sheets; beltings to thicknesses as low as 8 mils (or down to 3 mils by inflation process); thick-wall tubing both flexible and rigid; channels and other sections for car fender piping; weather-stripping; etc.

Other major uses for the machines are compounding, coloring and pelletizing. In compounding, plastic materials are mixed with plasticizers, heat stabilizers, sometimes lubricants, and completely mixed and extruded in a single operation.

Clear polystyrene can be mixed with dyes or pigments, fed through the twin screw extruder, and cut or chopped to make colored granules ready for injection

This Stokes-Windsor extruder press compounds, extrudes, colors and pelletizes.

STRETCH OUT YOUR STAINLESS, TOO

There *are* ways to stretch out your supply of stainless.

For example, you may be using a grade or finish of stainless that is in extreme demand when another similar one, not as tight, could do the job adequately.

Our metallurgical staff and stainless fabricating specialists are ready to help you look into this matter and to advise you on more readily-available types of stainless that will do a satisfactory job. Feel free to call on us for this specialized help.

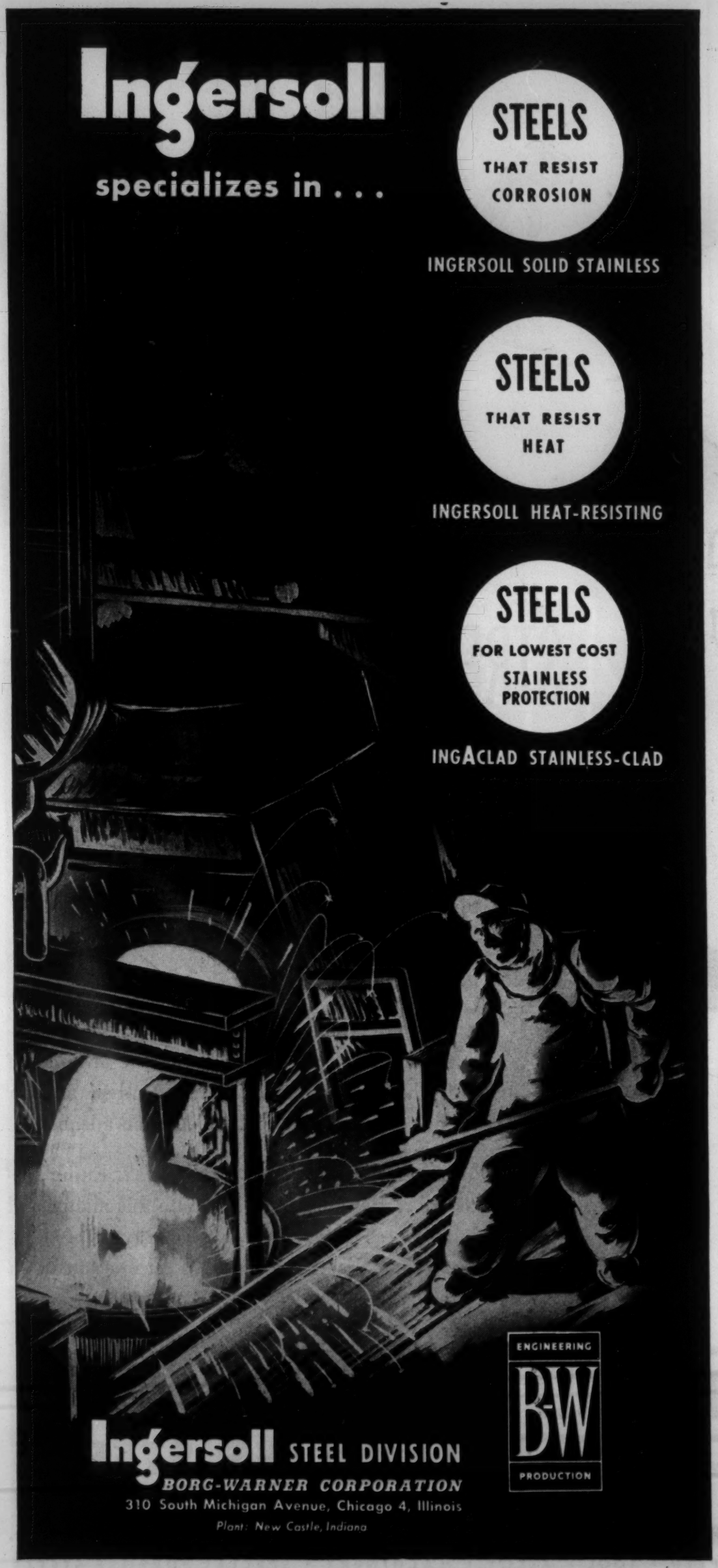
CRUCIBLE first name in special purpose steels

52 years of Fine steelmaking

STAINLESS STEEL

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

REZISTAL STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS



New Materials and Equipment

molding or re-extrusion as finished products.

The mechanical superiority of the new extruder rests in a great measure on the multiple screw, which exercises a positive and constant pressure on the plastic material fed to the barrel and forced through the die. There is a complete absence of pulsation; therefore, uniform thickness and close tolerances can be counted on, even for products with adjacent sections of different width. Another feature of the extruders is that output of two or more machines can be combined to yield a wide range of interesting multi-color and multi-material products.

The extruders are available in three models: The RC-65 and the RC-100, twin screw extruders; and the RC-200, a triple screw extruder.

Complete Line of Wet Blast Chemicals Announced

A complete line of abrasives for wet blasting machines is available directly from stock, according to an announcement made by *American Wheelabrator & Equipment Corp.*, Mishawaka, Ind. Sizes supplied range from 80 to 2500 mesh, and they are packaged in convenient 50-lb weights for easy charging of the machine and storage simplification. They are shipped in sturdy corrugated cartons which withstand rough handling.

The company is also prepared to provide from stock all of the other chemicals needed for wet blasting. Anarust, the rust inhibitor, embodies two characteristics new to inhibitors: being liquid in form, it goes in solution immediately, and it virtually eliminates the staining normally expected with inhibited water.

Anaset, an anti-packing chemical, completes the company's line of wet blasting supplies.

Hydraulic Press Combines Straightening and Forcing Operations

A 75-ton capacity press, specially equipped for double-duty performance, has been introduced by *Elmes Engineering Div., American Steel Foundries,* Cincinnati 29.

A long table is provided for use of the press in straightening gun barrels. This table is removable, making the press usable as a general-purpose straightening

You're always right with AUTO-LITE

Plastics

• Plastics and plastic-metal combinations are opening new fields in design as illustrated by these few of many assemblies made by Auto-Lite. Here under one roof at Auto-Lite's great Bay Manufacturing Division in Bay City are the technical skills and production capacity for a new art rendered in plastics. The artistic skill of Auto-Lite's Art and Style Division is available on matters of design and development. Address inquiries to:

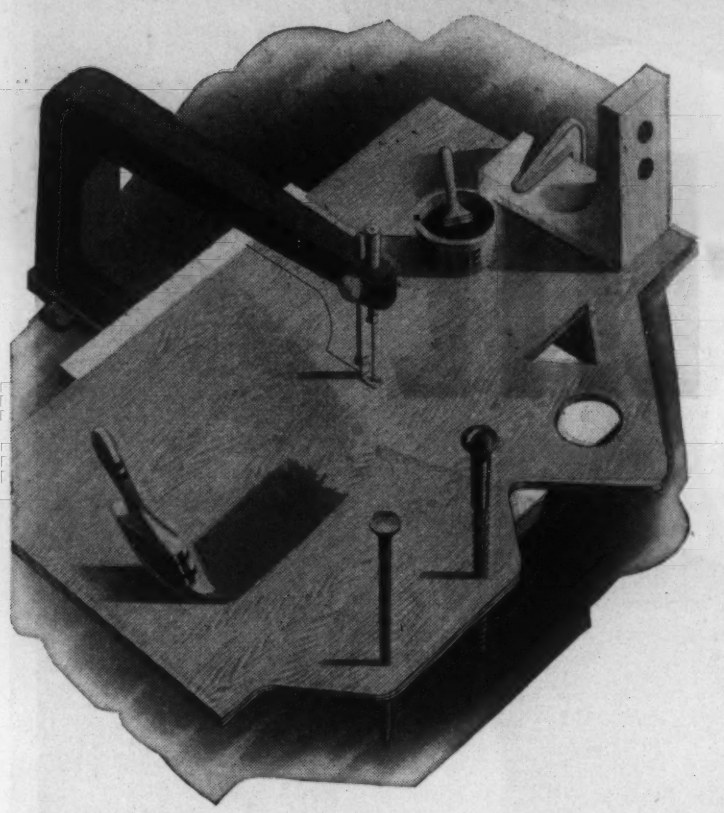
THE ELECTRIC AUTO-LITE COMPANY
Bay Manufacturing Division
723 New Center Bldg., Detroit 2, Mich. • Bay City, Mich.

Tune in "Suspense!"... CBS Radio Mondays... CBS Television Tuesdays

PLASTICS • WIRE & CABLE • DIE CASTINGS • INDUSTRIAL THERMOMETERS

Only plywood gives you all 6

WORKABILITY



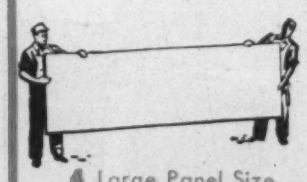
FAST fabrication and easy workability come naturally to Douglas fir plywood. These cross-laminated real wood sheets can be worked or machined to *any* shape. It can be sawn, planed, finished like ordinary wood . . . but *unlike* ordinary wood, plywood can be fastened close to the edge without splitting . . . jigged to indicated shapes, bent, drilled. Won't shatter, split or puncture. May be machined to the hairbreadth tolerances required in pattern making, yet it works with ordinary tools.

Workability is but one of many advantages which make plywood the standout choice for hundreds of construction, manufacturing and maintenance jobs. Douglas Fir Plywood Association, Tacoma 2, Washington.

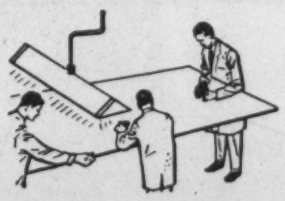
1 Workability

2 Cross Laminated Strength

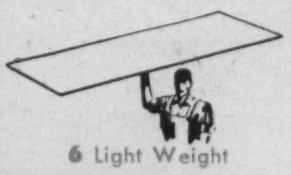
3 Attractive Appearance



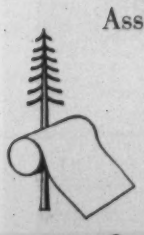
4 Large Panel Size



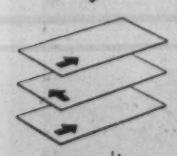
5 Tested Quality



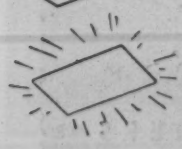
6 Light Weight



Douglas fir plywood is real wood, made by "unwinding" giant logs



into thin wood sheets which are inseparably cross-laminated



to form large, light panels having beauty and great strength

Douglas Fir Plywood

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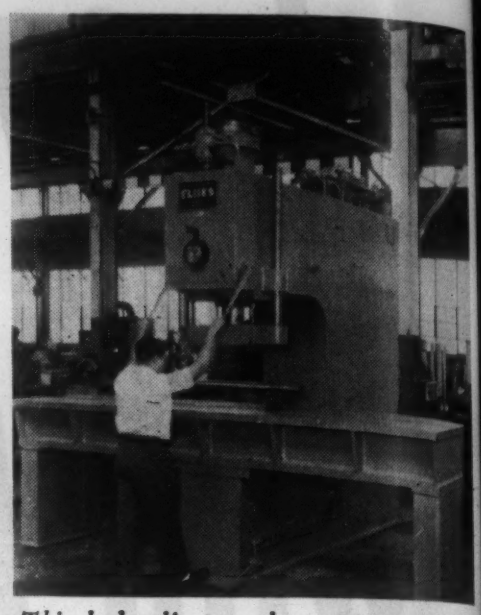

This hydraulic press has a 75-ton capacity, and is specially equipped for double-duty performance.

press, and in addition, an opening in the bed provides for forcing operations. The dual hand lever is interlocked with the foot treadle—an important safety feature. The ram will not descend until both of the hand levers and the foot treadle are depressed.

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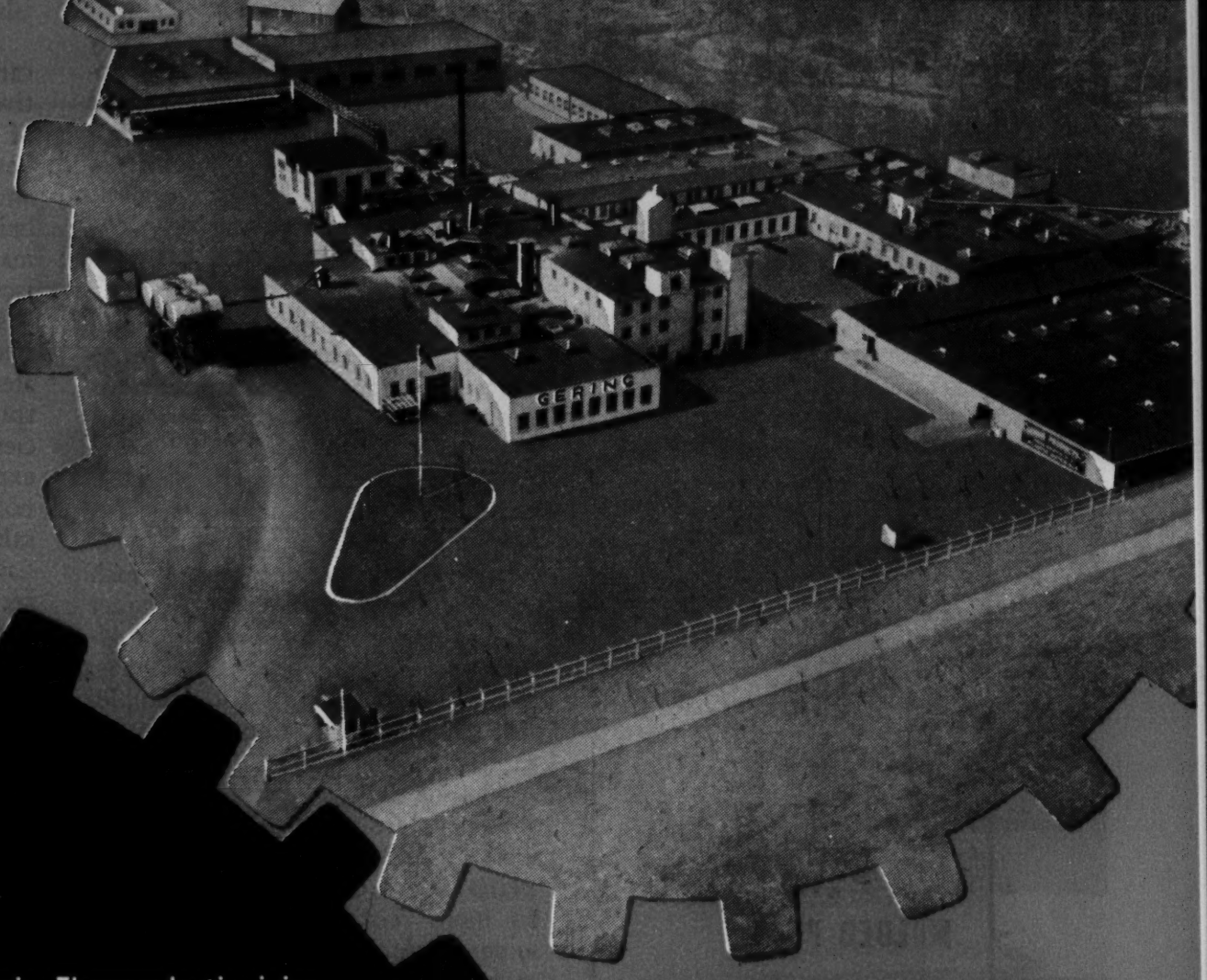

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A Critical Look at Salt Spray Tests

Continued from page 81

rence on the other. From our experience, materials and process engineers appear to agree pretty well on the limitations of the salt spray test, and the major difficulties appear to be created mainly by the equipment and end-product designers and manufacturers, the errors of whose ways would be minimized if they would submit their products, drawings and specifications to materials engineers for review.

Although agreeing readily with Mr. LaQue's technical tenets, it may be well to emphasize to a somewhat greater degree that there do exist some types of applications in which the salt spray test serves a useful purpose. This test is an idealized (though definitely not ideal) accelerated test and, as typical in such tests, is always fraught with danger and misleading conclusions. Although not completely analogous, one might point out, for example, that the results of impact tests are very often mis-applied and that the results of fatigue tests on smooth specimens are sadly misused to predict the behavior in service of materials under conditions which bear no more relation to the test than some exposure environments to salt spray. Nevertheless, these mechanical tests, as well as the salt spray test, when used with full recognition of their deficiencies and limitations, and particularly when correlated and interpreted with engineering knowledge and in the light of service experience, serve a useful purpose. In some cases, this purpose may be simply one of general orientation (where specific end-use is not known), *i.e.,* one step in getting some general, qualitative data of how a new material behaves as a preliminary to more specific, exhaustive and definitive evaluation.

Primarily, however, the major usefulness of the salt spray test, in the undersigned's opinion, is to check a sample of a particular material, under carefully specified conditions, to determine if similar results are obtained as were previously obtained on samples of supposedly identical or very similar material or finish. To apply the results usefully, the interpretation and criteria of inspection must have previously been carefully and reproduceably established directly or indirectly through the medium of service exposure. In this sense, the salt spray test serves as a useful inspection tool or means of comparison of like materials or finishes under like situations.

Another example where the test can be helpful is a preliminary sensitive indicator in exploring methods of insulating joints between magnesium and dissimilar metals. Vinyl and other organic films are currently being used in aircraft to insulate magnesium from aluminum at contact areas, and the salt spray test has served as a rough but rapid screen in devising adequately insulated and sealed joints, since salt spray rapidly shows up any deficiencies in these joints. Limited service experience supports this. It is to be noted that this "indicator use" of salt spray does not contradict Mr. LaQue's comments on galvanic effects, with which the undersigned agrees.

Mr. LaQue mentions the usefulness of salt spray on aluminum and its alloys. With this the undersigned concurs, insofar as judging the simpler, pitting-type of corrosion for marine exposure. For other types of corrosion, such as intergranular and stress corrosion, the salt spray test is not suitable. Caution should be used also in applying it to aluminum-alloy coatings. For example, in comparing a series of aluminum-magnesium coatings on steel, one combination gave 556 hr before "failure" in salt spray and 720 hr in an industrial seaboard atmosphere, whereas another combination gave over 1,000 hr in salt spray but only 168 in the same outdoor exposure; *i.e.,* an increase of more than 2:1 in salt spray and a reduction of more than 4:1 in outdoor exposure.

In summary, the undersigned agrees with Mr. LaQue on the general uselessness of the salt spray test as an absolute test or a prediction-of-life test or as an uncorrelated research tool, but desires to emphasize to a somewhat greater extent that there are a few types of applications where the engineering and intelligent use of salt spray is advantageous.

8-Hr Test Sufficient

W. L. Pinner, Manager of Research, Houdaille-Hershey Corp.

Mr. LaQue's paper is very timely, coinciding as it does with the publication of the report of a Special

(Continued on page 158)

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Advisory Committee on Accelerated Corrosion Tests, of which he served as Chairman. The acceptance of his committee's report has resulted in the condemnation of the salt spray test by the Research Committee of the American Electroplaters' Society to the extent that it has activated its Project No. 15 titled "The Study of Accelerated Corrosion Tests".

A review of the background information originally compiled at the Bureau of Standards reveals that a firm basis for a strict salt spray specification is questionable. This statement is further emphasized by the present ASTM revision of the salt spray test in which the temperature of the test has been increased from room temperature to a value of 95 F. Unfortunately, any test of this kind will probably never be as exact as a go or no go test such as is involved in dimensional or physical property specifications. It is, therefore, not unlikely that there may be continued controversy over any test which may be devised to measure quality of this sort, and yet it is to be hoped that a test may be developed which will more factually duplicate service failures and will more equitably penalize faulty manufacturing procedures.

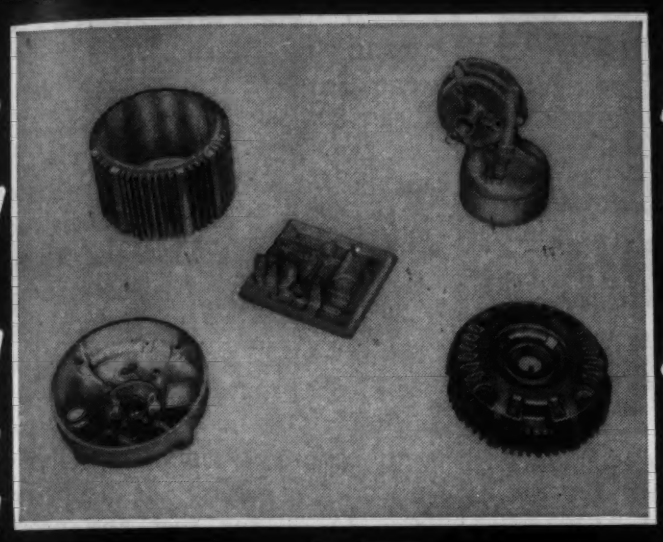
Over a period of many years it has been demonstrated both experimentally and on service parts that, in the metal finishing industry, the applied metal thickness coating is far and beyond the most important consideration in terms of service, provided of course that the proper choice of metals is made for the service intended.

The salt spray test has time and again completely failed to make a valid distinction between parts coated with proper thicknesses as opposed to those improperly coated. In the interim period, during which the salt spray is in disrepute and until a valid substitute is found, it is the writer's opinion that acceptance tests should be based on this recognized factor of plate thickness with, when applicable, a specification as to the type of coating that should be used particularly with reference to its physical properties, principally its ductility and hardness. The writer feels that in this interim period there is little if any justification for a salt spray test in excess of 8 hr which is sufficient to reveal gross discontinuities in metallic coatings stemming from faulty manufacturing. The writer does not feel that

(Continued on page 160)

In The

Electrical Equipment Industry Die Cast Parts of Aluminum and Magnesium Alloys Can Play a Vital Part



Typical of parts that are successfully and economically die cast from both aluminum and magnesium alloys are, as illustrated above: electric windshield wiper housing; electronics base part; motor end bells and a motor field ring. Several important factors give ready reasons for this method of manufacturing:

COST: Great savings are effected in labor formerly required for machining and finishing—(most of the holes are cored)—through this precision method for producing an immense variety of parts.

DIMENSIONAL STABILITY: These tough and strong alloys, when die cast, help maintain bearing fits and tolerances.

HEAT DISSIPATION: Parts, such as these, die cast from aluminum and magnesium alloys, give adequate dissipation of heat through the high thermo-conductivity of the parts as compared to other materials. It is easy to design into parts such features as heat dissipating fins.

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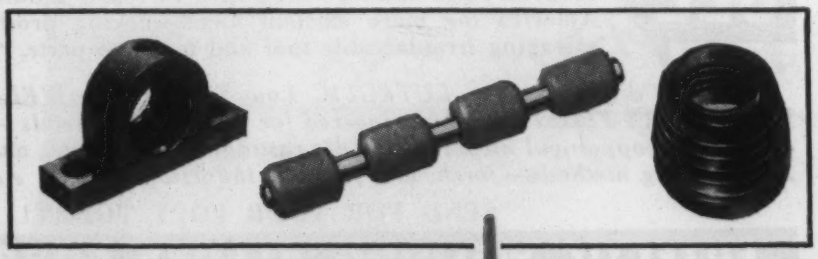

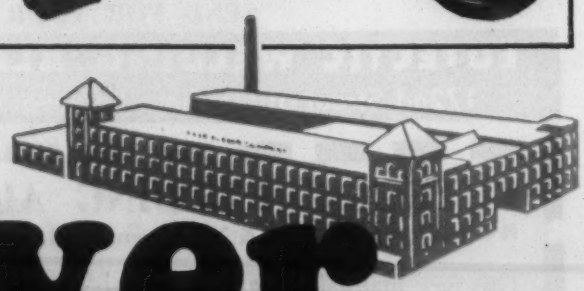

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industry should any longer attach significance to corrosion resulting from longer periods of salt spray life for reasons adequately set forth in Mr. LaQue's excellent paper.

Useful But Not Infallible

William Blum, Chief, Electrodeposition Section, U. S. Dept. of Commerce, National Bureau of Standards

I merely wish to point out a distinction which, while fully recognized by Mr. LaQue, has not been sufficiently emphasized. There are two very distinct but related purposes for which any proposed accelerated test, *e.g.*, of metals or coatings, may be used. First, to aid in the selection of a process or product to meet certain service requirements, and second, to determine whether products of a given type are of a specified quality. These two applications involve, respectively, research and testing. It is not reasonable to assume that any procedure will fully meet both purposes.

The factors that affect the performance of a metal or coating are so diverse and so variable that it is not conceivable that any simple or even complex procedure can in a short time reproduce all of these factors, much less the relative magnitudes of their effect. While the salt spray or any other laboratory procedure may serve to show the principal effects of certain factors, such as the composition and concentration of a given solution, temperature, and aeration, upon the performance of a material, the results have no necessary bearing on the selection of materials unless it has been shown by long experience that at least a rough parallel exists between these results and one or more types of service. Experience with the salt spray test and other proposed accelerated tests shows that efforts to reach this goal by means of any accelerated test hardly deserve to be called "a will o' the wisp", as they will not even come that close. There is no short-cut to experience!

Once a material or process has been selected, it is necessary to define those properties or requirements that are essential to an acceptable product, in other words, to write a specification. The means used to measure required properties of a coating, such as thickness, hardness, luster and protective value, are all "accelerated tests", otherwise they could not be used as a basis of ac-

(Continued on page 162)

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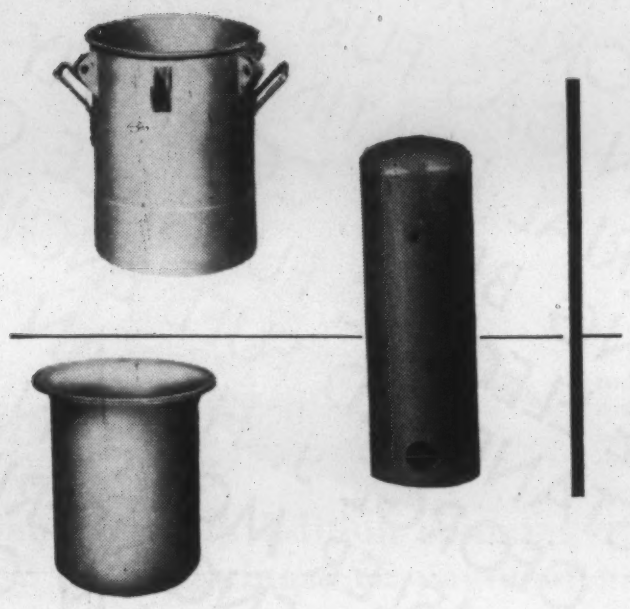

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ceptance of deliveries. The use of the salt spray test in acceptance specifications is merely a means of measuring some property of a given coating that is known or believed to be related to its performance, *e.g.*, the porosity of noble coatings on steel. To be effective it is not necessary that the porosity test itself should reproduce any conditions of service. The ferroxyl test for porosity has some value even though no one expects the plated particles to be exposed in service to ferricyanide!

As pointed out by Mr. LaQue, the salt spray test, with all its limitations, has a definite value in locating pores in noble coatings on steel. Even though, as pointed out by Strausser and by Thon, the salt spray may produce pores that were not originally present (or at least not previously detectable), it is at least possible that these "supplemental" pores may be the result of selective depth attack by the salt solution, which, in turn, may be related to the structure or homogeniety of the deposit. If this possibility is confirmed by further studies, more research on the salt spray test and its possible modifications is fully warranted. Until then, the salt spray may well serve as a useful, but not infallible acceptance test for metals or coatings.

Not as Acceptance Test

K. G. Compton, Bell Telephone Laboratories, Inc.

The views expressed by the author are quite parallel to my own. It is unfortunate indeed that specification writers, particularly within the government agencies, resort to arbitrary use of the salt spray (fog) test as a gage of quality and expected performance for so many kinds of equipment. While the test has some usefulness in the study of materials by competent corrosion engineers, it certainly has no place in specifications for housed equipment such as the electronic gear to which the author refers.

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(Continued on page 164)

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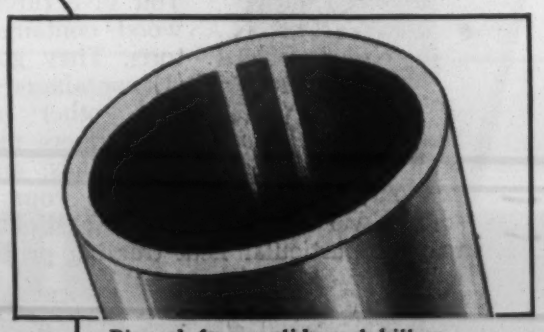

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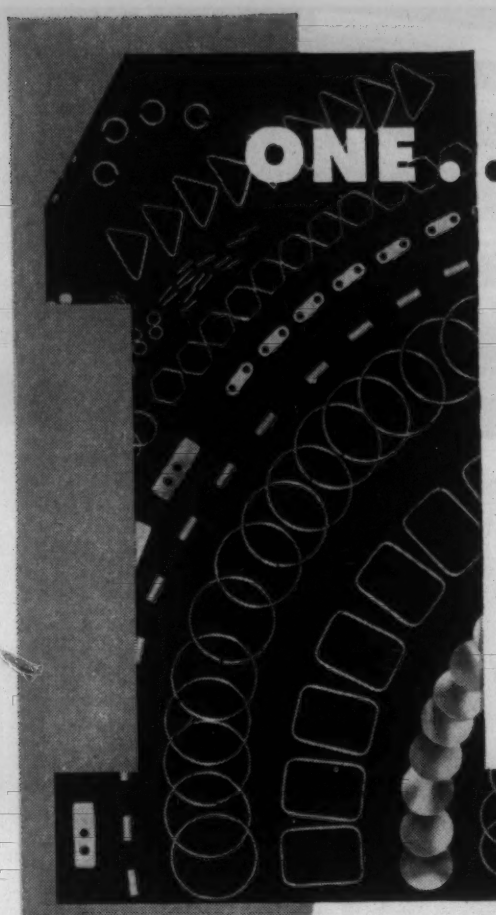

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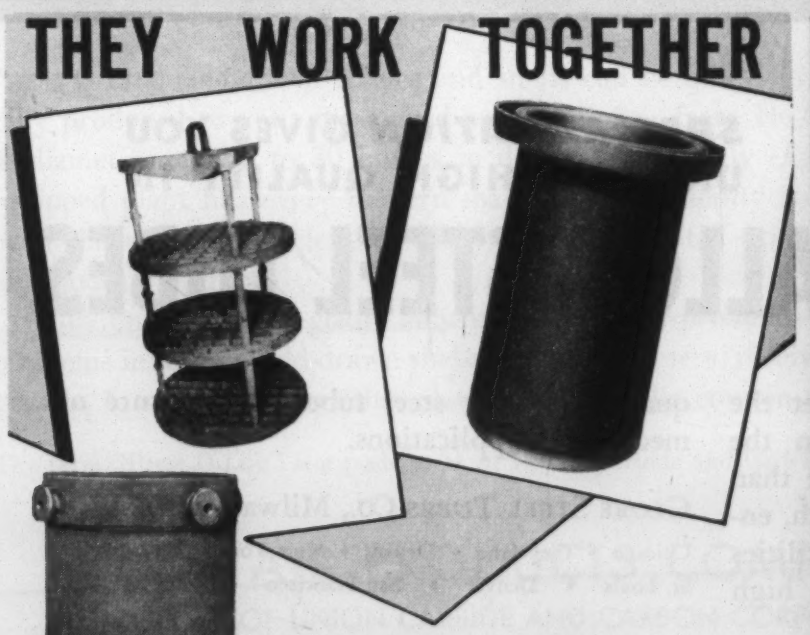

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Salt Spray Tests

a number of locations to create a background from which the probable corrosion behavior of the material may be predicted. It has been used as one of the tools for following the effect of changes in processing or in the composition of a material. For example, the effect of heat treatments on the corrosion resistance of chromate surface treatments. It is our opinion that this test should be removed from the vast number of government specifications for housed equipment where humidity and condensation are the most severe environment it will encounter.

The case against the test for acceptance of outdoor equipment is less clear cut but no less real. A more realistic approach would be the reliance upon known performance of materials of known composition under the required types of exposure. This, however, would call for knowledge and judgment on the part of the user and a disclosure of the composition of the materials employed on the part of the supplier.

Because the salt spray test is of use to corrosion engineers, its standardization is important in that it provides corrosion engineers with a common language in describing the behavior of materials. The same thing is true of atmospheric exposures if a common denominator is location. Unfortunately, much of the atmospheric testing is carried out at a private test plot where there is no cross check on the relative behavior of various materials. More work like that carried on by the American Society for Testing Materials is needed.

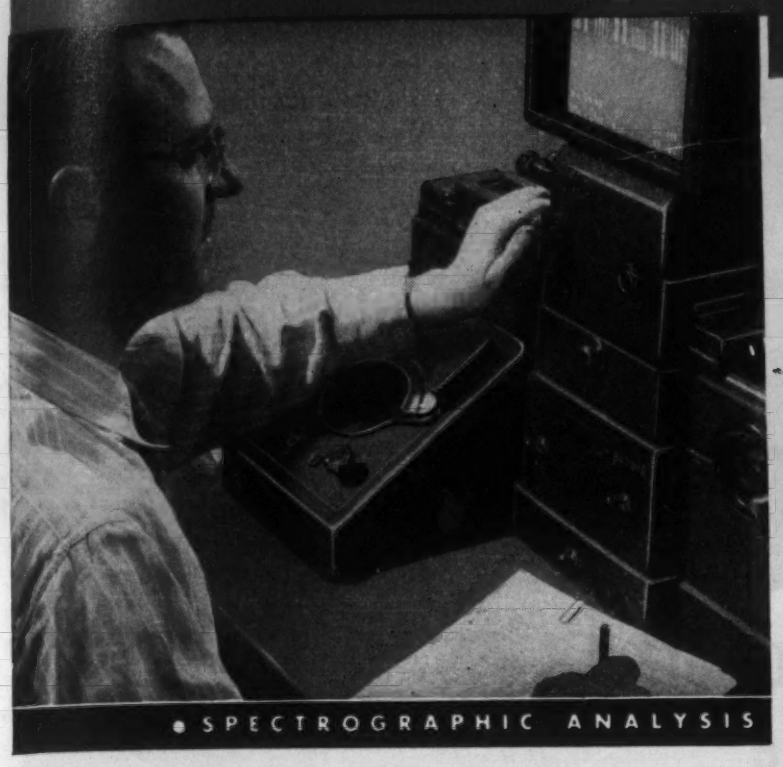
Nothing Better Proposed

C. H. Sample, The International Nickel Co., Inc.

Mr. LaQue has presented several strong and irrefutable arguments against the salt spray test. His advice against indiscriminate specification and use of the test, as well as interpretation of test results, is especially timely, as the rearmament effort will undoubtedly involve many materials and equipment specifications containing salt spray requirements. While the salt spray test unquestionably has many faults and limitations, the writer is of the opinion that the principal cause for complaint lies not so much in the test per se, but in the failure of specification writers, researchers and others to recognize or appreciate

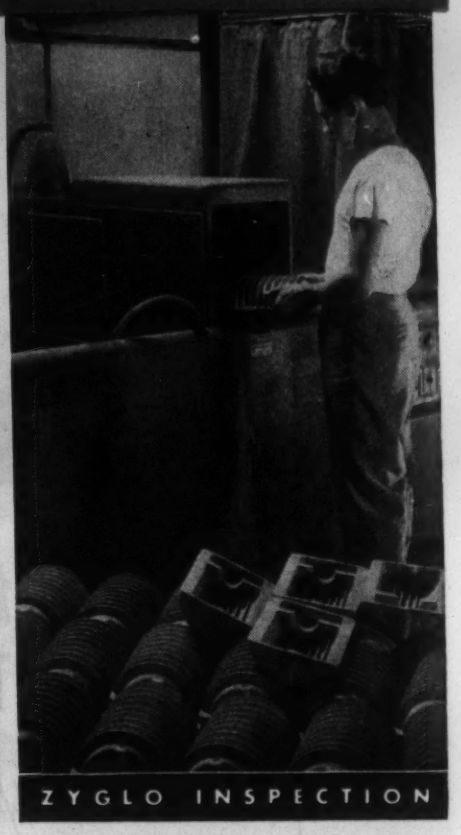
(Continued on page 166)

Don't Let "Castings Troubles" Slow Down Your *Defense Production*



• SPECTROGRAPHIC ANALYSIS

X-RAY INSPECTION



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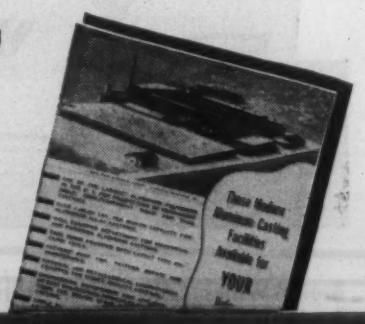
Write for your copy of new Bulletin No. 20A illustrating and describing our facilities for supplying the castings you want, when you need them.

Send blueprints for recommendations and estimates on your aluminum castings requirements.



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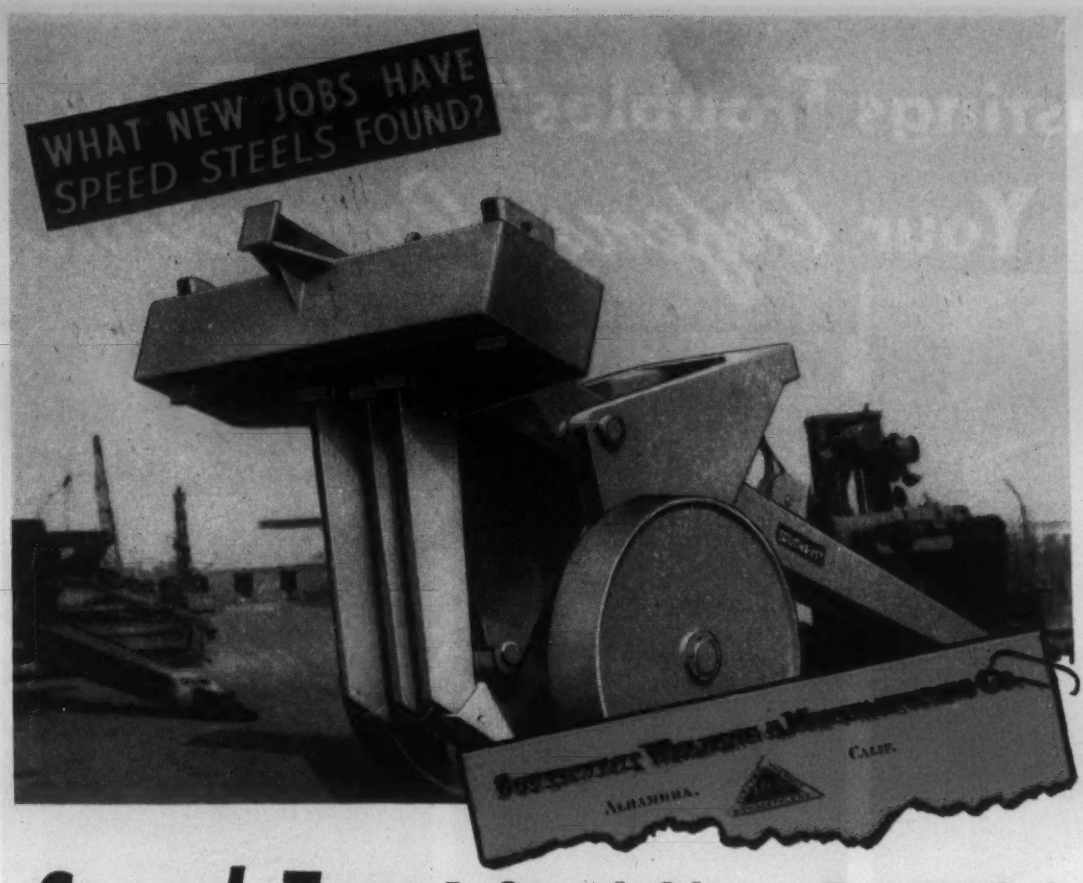
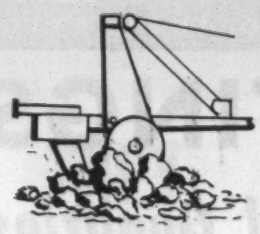


Speed Treat Steel Gives Powerful Brute A Tremendous Bite



The big teeth of this Southwest Cable Ripper have to penetrate rock hard surfaces up to 60" deep and withstand tremendous shock loads. A hard-packed airport runway, for example, snapped off ordinary steel shanks like toothpicks. To give this powerful brute teeth with a real bite Southwest is making them of Speed Treat (x1545) Plate Steel.

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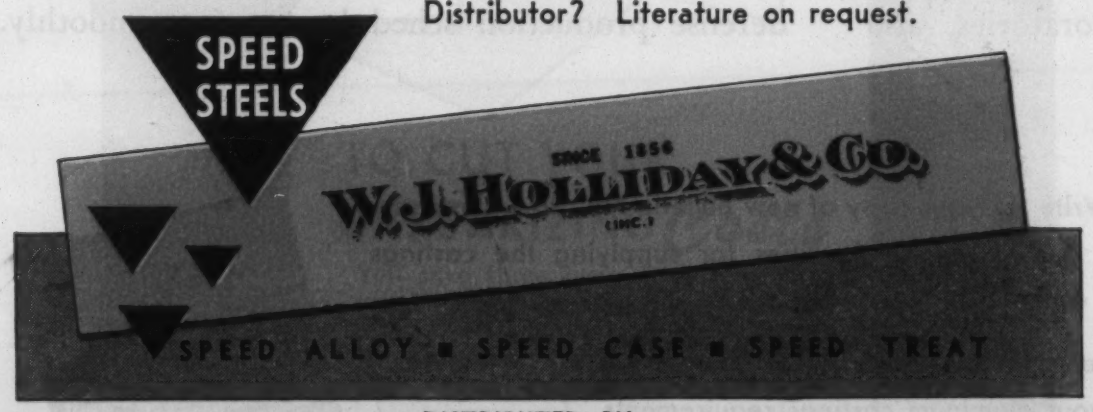

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these faults and limitations. This has lead to widespread misapplication and misuse of the test, and in many instances, to unwarranted importance being attached to the salt spray test results.

In criticizing use of the test, however, we must keep in mind that for some uses, such as rough factory inspection of certain production items, nothing better has as yet been proposed as an alternate. The writer cannot agree entirely with Mr. LaQue's condemnation of the test as a research tool. Again, if its limitations are recognized and the results interpreted in the light of such limitations, it can and does serve a useful purpose. For example, it has been useful in the development and improvement of chromate type supplementary finishes for zinc surfaces. This does not mean, however, that a better test for that purpose may not exist or be developed. Nor does it mean that because a particular cromate treatment will prevent the white corrosion of zinc for 200 hr in the salt spray test, that treatment will necessarily prolong the protective life of the zinc coating when it is boldly exposed to the atmosphere. To imply that such is the case, in the absence of experimental proof of satisfactory correlation, is an example of the misuse of the salt spray test results rather than cause for criticism of the test itself.

Alternate Wetting and Drying Suggested

C. J. Walton, Assistant Chief, Chemical Metallurgy Div., Aluminum Research Laboratories, Aluminum Co. of America

F. L. LaQue's article on the salt spray test presents some interesting aspects of this widely used and often misused accelerated test. He concedes that the salt spray has merit for control or inspection, but concludes that the test is inadequate for research.

Our experience at Aluminum Research Laboratories shows that the salt spray test, although not an all-purpose test, can be used for research where reasonably good correlation can be established between results in salt spray and those in a natural marine environment. If such a correlation has not been or cannot be established, the results of the salt spray tests can be very misleading.

We concur with Mr. LaQue, that for research it is imperative that the

(Continued on page 168)

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Spongex CELL-TITE floats can't be punctured... cannot leak

In many ways permanently buoyant *Spongex Cell-Tite* (hard cellular rubber) makes better floats than those of hollow metal design. Stronger than hollow metal floats, *Cell-Tite* floats cannot be dented or pressed out of shape. Unlike metal, *Cell-Tite* is not subject to expansion and contraction, caused by temperature changes.

Floats of *Spongex Cell-Tite* have no raised seams to waste space... their volume completely occupies their greatest dimensions. As the density of *Cell-Tite* can be varied over a wide range, you are permitted changes in flotation properties *without* changing molds, tooling and other costly-to-alter elements of your design.

Floats might be the last thing on your mind. But if cellular rubber (hard or soft) is on your mind, let's talk it over. Our development facilities plus 29 years experience compounding cellular rubber are at your service. There's a lot of preliminary help in our booklet—"Properties of and Technical Data on Cellular Rubber." Write for it—it's free.

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Technical Service Data Sheet

Subject: HOW TO MAKE PAINT STICK TO GALVANIZED IRON WITH LITHOFORM®

INTRODUCTION

"Lithoform" forms a dense, zinc phosphate coating on zinc, cadmium, and galvanized surfaces—including Galvanneal, cadmium plated steel, zinc plated steel, zinc base alloys, and zinc base die castings. The "Lithoform" coating, which is non-metallic and inactive, retards reaction between alkaline metal oxide and the paint film. Peeling and loss of adhesion are thus greatly retarded on painted Lithorized zinc and cadmium.

ADVANTAGES OF "LITHOFORM"

"Lithoform" forms a durable bond for paint. It is economical. It eliminates frequent repainting. It protects both the paint finish and the metal underneath. "Lithoform" meets these Government Finish Specifications:

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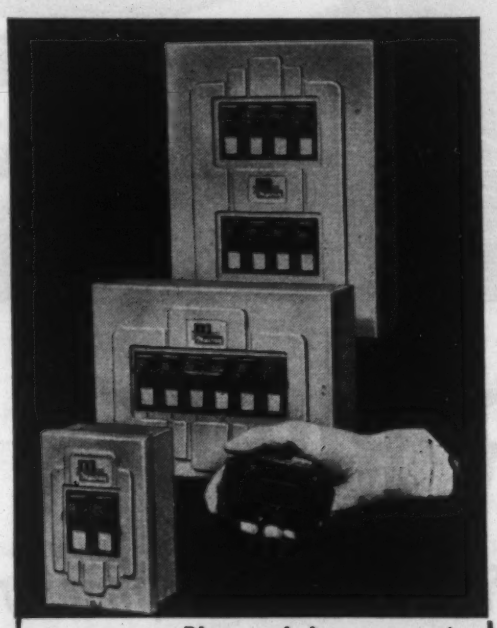

Photograph by courtesy of Murray Manufacturing Corp.

Murray Circuit Protectors are fully magnetic and provide maximum protection for both domestic and industrial wiring. Housings are of galvanized iron which is Spray Lithorized for long paint life.

THE LITHORIZING PROCESS

"Lithoform" can be applied by brushing or spraying the work with simple hand equipment, by dipping it in tanks, or by spraying it in industrial power washers.

Brush. Galvanized bay windows, cornices, rain gutters, hardware, building siding, truck panels, and farm equipment are typical of the many surfaces that are treated effectively with Brush "Lithoform".

Dip. This grade is used for coating cleaned surfaces of such typical products as cabinets, refrigeration condensers, etc., immersed in heated solutions in tanks.

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salt spray test reproduce the same pattern of corrosion encountered in a marine atmosphere. In the case of aluminum alloys, we observed many years ago that the conventional continuous exposure to salt spray, whether 20% or 3½%, did not reproduce the pattern of corrosion caused by a marine atmosphre but that it was reproduced more closely by the alternate wetting and drying action of intermittent exposure to salt spray. The latter type of test has been used by us for research.

Broadly speaking, the salt spray test rates various aluminum alloys in about the same order as does exposure to marine environments. The magnitude of the differences among aluminum alloys or their modifications, however, is often exaggerated greatly by the salt spray test. Galvanic corrosion between dissimilar aluminum alloys or between aluminum alloys and non-aluminum metals is often far more intense in salt spray than usually encountered in the atmosphere, including relatively severe seacoast atmosphere. Because of these exaggerated effects, we do not rely on the salt spray test for the evaluation of variations in alloy composition or galvanic effects of dissimilar metals, although this accelerated test may be used at times to indicate the general trends expected or to simulate exposure conditions of an unusually severe nature.

On the other hand, the salt spray test has been found to produce the same type of attack, pitting, intergranular, etc. in aluminum alloys as a natural marine environment; and it has also been rather dependable for evaluating the resistance of aluminum alloys to stress corrosion under saline conditions. The salt spray test, therefore, has been a convenient and useful research tool for expediting the evaluation of the effects of various metallurgical treatments on the resistance to corrosion and stress corrosion cracking of aluminum alloys.

It would be well to add that we now prefer an alternate immersion test in 3½% sodium chloride solution to the salt spray test, especially for simulating exposure to sea water and for studying the performance of aluminum alloys under stress. Simple alternate immersion (10 min per hr) in salt water causes less overall surface attack than the salt spray, but the stress corrosion data obtained correlates well with that secured from exposing stressed specimens at the seacoast or in sea water.

a few words about alloy steels

and how we can help you switch to

ALTERNATE ALLOY GRADES

You've probably had trouble getting the alloy steels you've been accustomed to running. You've got the headache of choosing the best available alternate alloys, plus the headaches of how to machine and heat-treat them.

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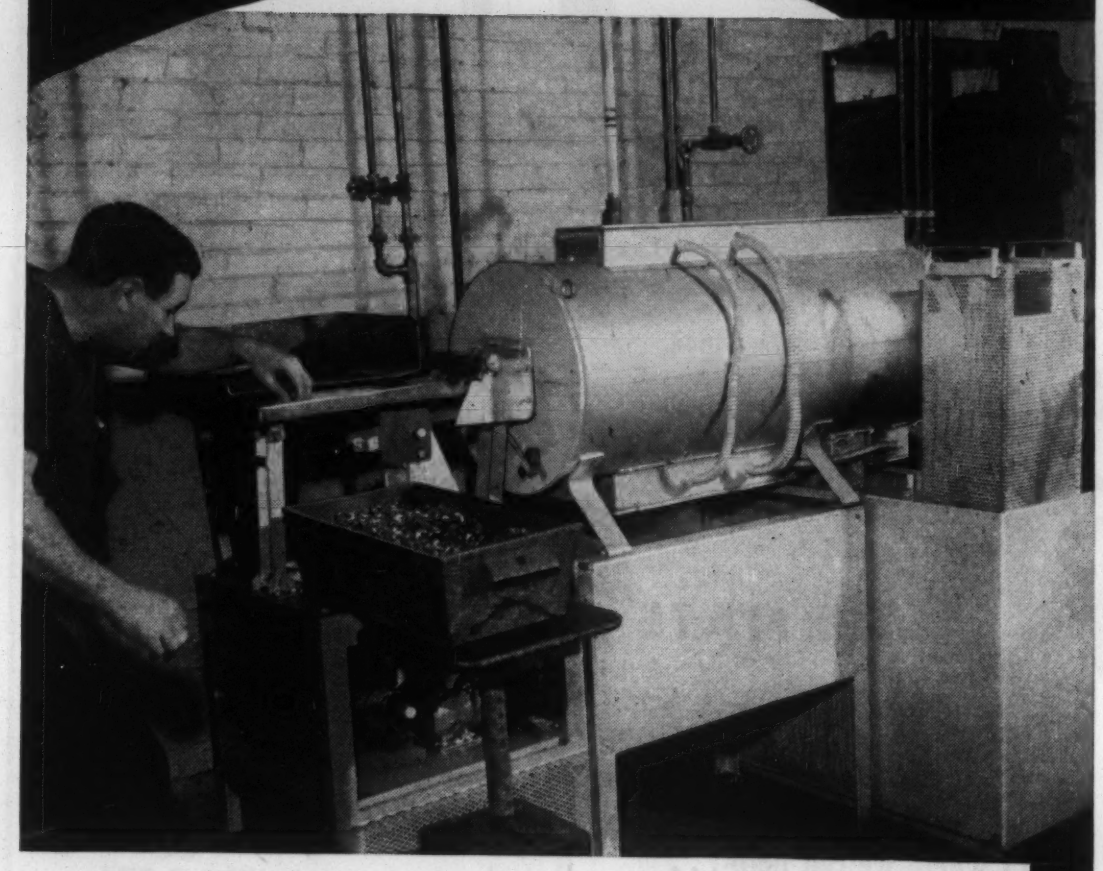
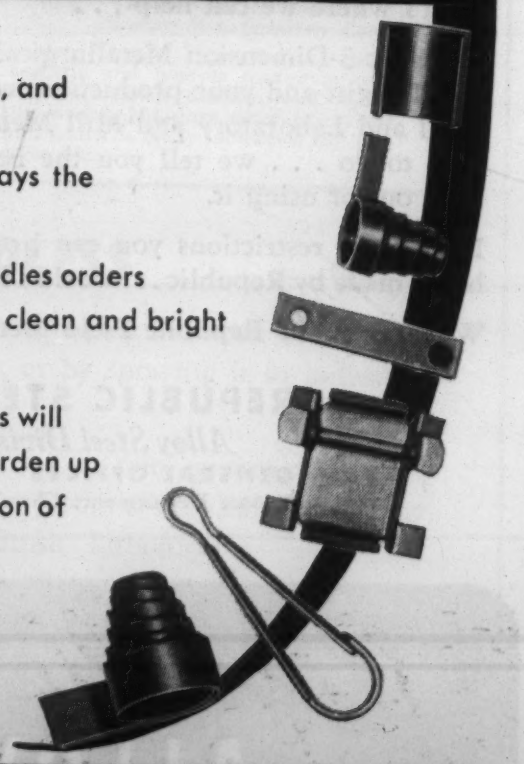


"We bright harden carbon, vanadium, and stainless steel springs without distortion in our Hevi Duty Shaker Hearth furnace," says the Raymond Mfg. Co. of Corry, Pennsylvania.

"Our Hevi Duty Shaker Hearth furnace handles orders faster, and work comes out of the furnace clean and bright with no scale or decarburization."

Hevi Duty standard Shaker Hearth Furnaces will carburize, nitride, dry cyanide or bright harden up to 150 lbs. of small parts per hour. Operation of this production machine is semi-automatic. Write for bulletin HD-850 today.



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Heat Treating Furnaces... Electric Exclusively

Dry Type Transformers *Constant Current Regulators*

News Digest

continued from page 13

other pipelines is still another possible use.

Roswell B. Whidden, Alcoa's manager of tube and extrusion sales, said the installation of the new press is being announced at this early date so that engineers will have advance notice and opportunity to consider some of their designs with the new press in mind.

As an indication of the potentialities of the new press, Alcoa will be able to quadruple the weight of its extrusions from 600 lb. per piece to 2300 lb. While maximum length of extrusions remains at 90 ft., the size which can be produced in that length increases from 6.7 lb. per foot of length to 25.5 lb., or from 5.6 sq. in. in cross-sectional area to 21.3 sq. in. Maximum circumscribing circle diameter for shapes may increase from the present 14 in. to 23 in.

The new press will not only be able to extrude shapes of a given thickness substantially larger in cross section than at present, but also shapes of a given size substantially thinner. For example, in one of the strongest aluminum alloys, 75S, it will be possible to make a 0.187-in. thick shape up to 16 in. in width, instead of 7 in. A 13-in. wide 75S shape may be shaved to a 0.156-in. thickness compared with a 0.437-in. thickness at present.

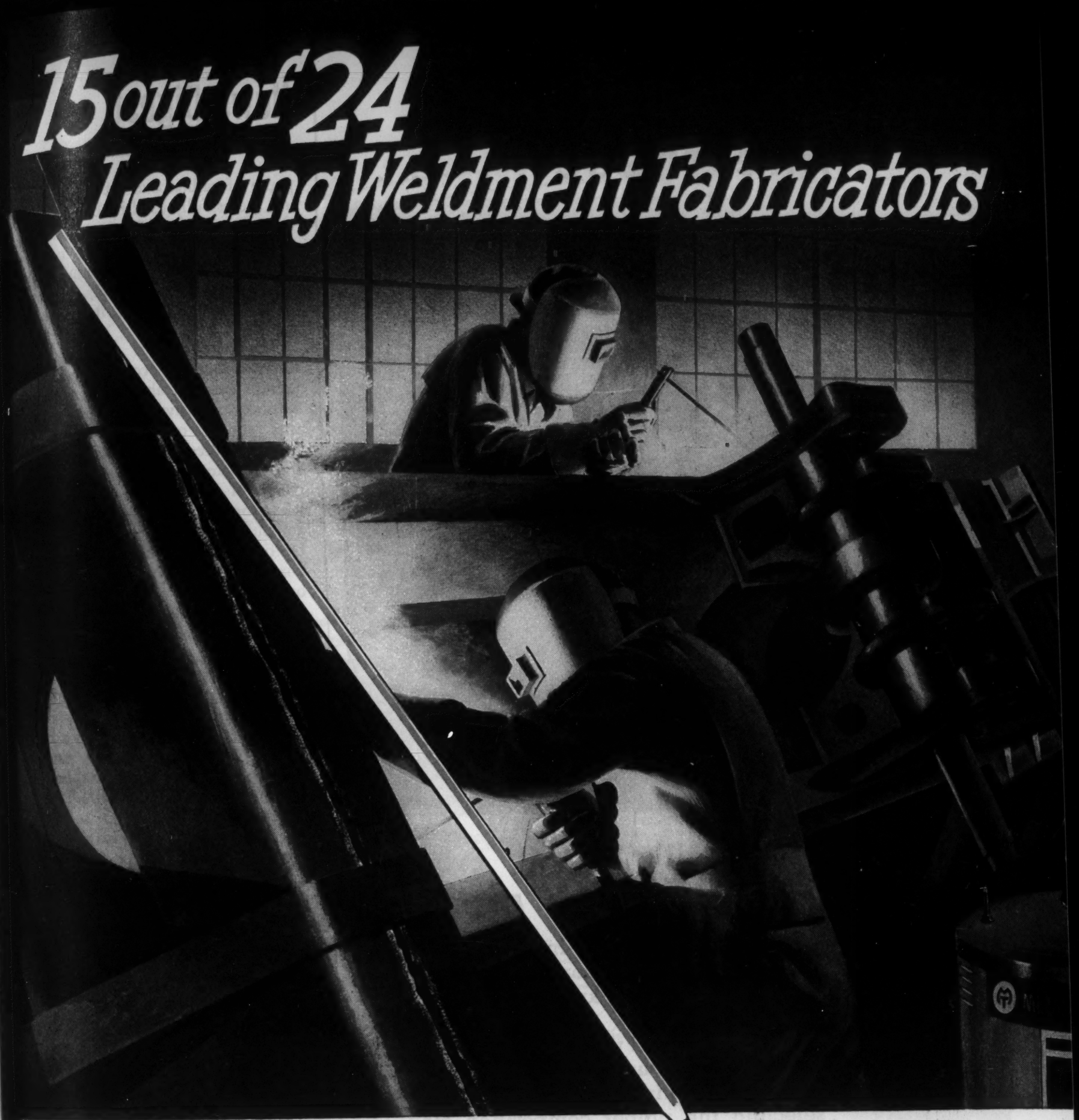
In 61S, 62S and 63S alloys, pipe can be extruded in sizes ranging through a 20-in. outside dia. Previous limit was 12 in. Maximum length will vary, depending on size and wall thickness, from 40 ft. for 20-in. ASA Schedule No. 40 (0.593-in. wall) pipe to 100 ft. for 20-in. ASA Schedule No. 10 (0.250-in. wall) pipe.

While the rearmament program continues, Mr. Whidden said, most work on the press will be related to military requirements, largely aircraft. But, he added, Alcoa stands ready to discuss designs and assist in every way possible any company whose engineers visualize a new product that might be made on the press.

Cobalt Isotope Used for Steel Inspection

Among the first industrial applications of the atomic age is an am-

15 out of 24 Leading Weldment Fabricators



*Among the twenty-four *top contract welding firms, fifteen regularly weld with Murex Electrodes.*

More of the leaders in important industries prefer Murex Electrodes in their welding operations because they can be sure of sound welding—high deposition rates for economy and speed of production.

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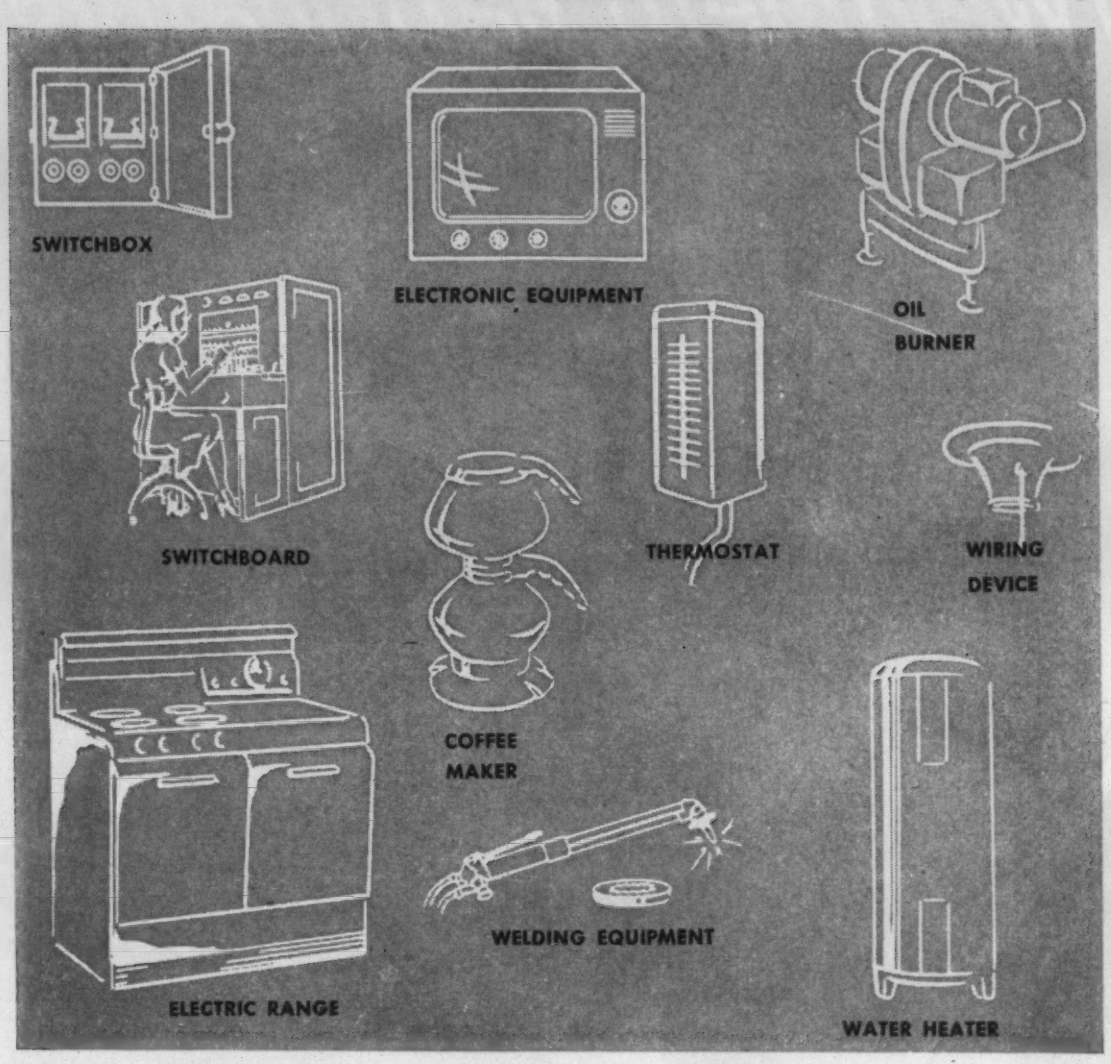

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STAR has played an important part in the design, engineering and volume production of porcelain components for many nationally known consumer and industrial products.
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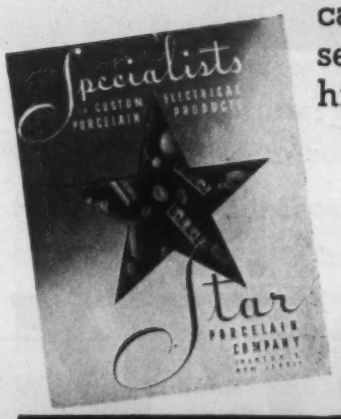

You will find STAR's new brochure very helpful—giving you the electrical and physical properties as well as design and application data on many types of ceramic bodies.

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News Digest

poule of radioactive cobalt wire, being successfully used by Empire Steel Castings, Inc. of Reading, Pa., for the examination of steel castings for the manufacturers of pumps and valves and for the food, chemical, textile and other industries requiring noncorrosive castings.

The advantage of the isotope is its relatively low cost compared to radium, and its ability to be used without expensive machines. It consists simply of radioactive cobalt wire, mounted in a circular holder, and elevated over the casting by means of a cross-arm attached to a laboratory stand. The height of the ampoule from the steel is determined by the thickness of the steel. Exposures range from one-half to five or six hr.

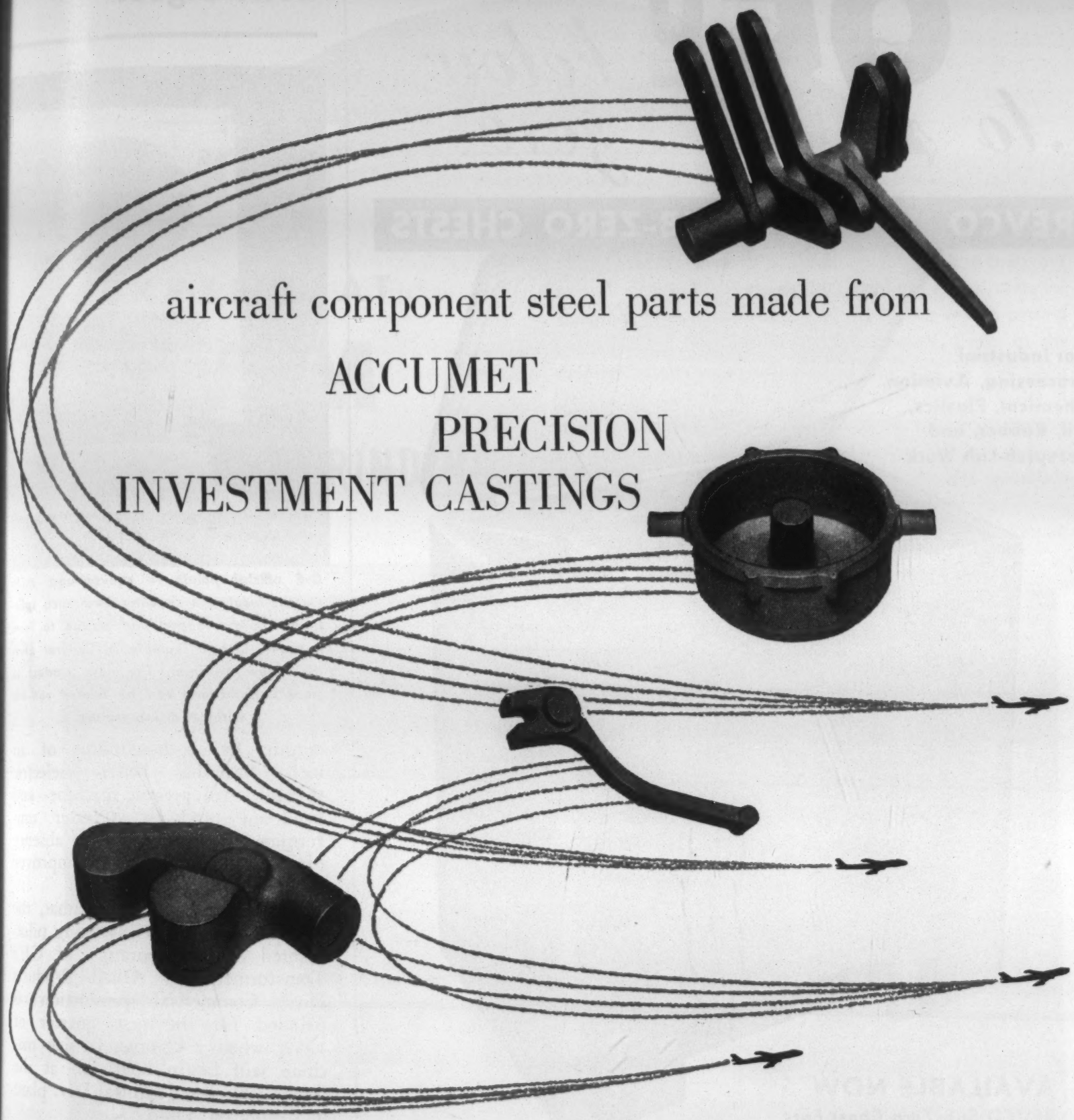
The isotope is said to speed the work of inspection, and it also has a distinct cost advantage over radium. It was purchased for $450. A comparable amount of radium, weighing 525 milligrams, would cost approximately $10,000. The unit has a half-life of 5 3/10 years, but can be used up to ten years, with diminished efficiency after the half-life period.

The isotope was purchased from a civilian chemical firm with the permission of the Atomic Energy Commission. No security regulations attach to it, since it is being commercially prepared and distributed.

New Process Fits Domestic Mica for Insulating Applications

The mica industry in the United States may be freed from dependence on foreign sources by a development that permits the utilization of domestic sources of mica for a variety of electric insulating applications, according to Robert L. Gibson, general manager of General Electric Co.'s Chemical Div. Heretofore, imports of mica from India accounted for the majority of this material used by the electrical industry because of the inferior quality of American supplies.

Key to the development is a special process by which minute mica flakes are so treated that a force is generated which holds the tiny particles together, Mr. Gibson stated. The resulting product is in the form of a continuous sheet produced in thicknesses ranging from two-thou-



aircraft component steel parts made from

ACCUMET PRECISION INVESTMENT CASTINGS

The pictured castings are currently being used to produce such important aircraft accessories as fuel injectors and regulators, carburetors, landing gear door latch mechanisms, rocket release mechanisms and radar equipment. Cast to close tolerances with smooth surface finish, expensive machining operations are avoided—resulting in saving of valuable time, reduction in cost and eliminating the need for hard-to-get machine tools. Also *Accumet Precision Investment Castings* permit the use of higher alloyed steels that are difficult or impossible to machine or forge, thus increasing the life or performance of the component parts.

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Crucible engineers and metallurgists are available to assist you in solving your design or production problems by the application of these Accumet Precision Investment Castings . . . that are playing such an important part in our National Defense Program.

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52 years of Fine steelmaking

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REVCO SUB-ZERO CHESTS

For Industrial Processing, Aviation, Chemical, Plastics, Oil, Rubber, and Research-Lab Work

AVAILABLE NOW

REVCO Sub-Zero Chest For Testing, For Shrink Fits, For Seasoning Gauges and Precision Tools . . . Completely equipped ready for operation, will accommodate parts or assembled units up to 23" long, 12½" deep, 9" high in the 1.5 Cu. Ft. model and up to 47" long, 16" deep and 15" high in the 6.5 Cu. Ft. model. Revco Sub-Zero Chests are designed and built to meet highest performance standards. They feature temperatures of 95° and 85° below zero, respectively, upon continuous running in normal room temperature. Other controlled Low-Temperatures readily attained.

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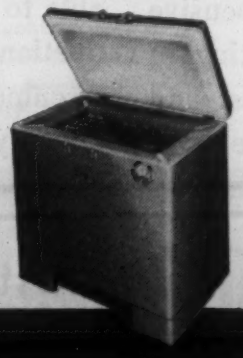

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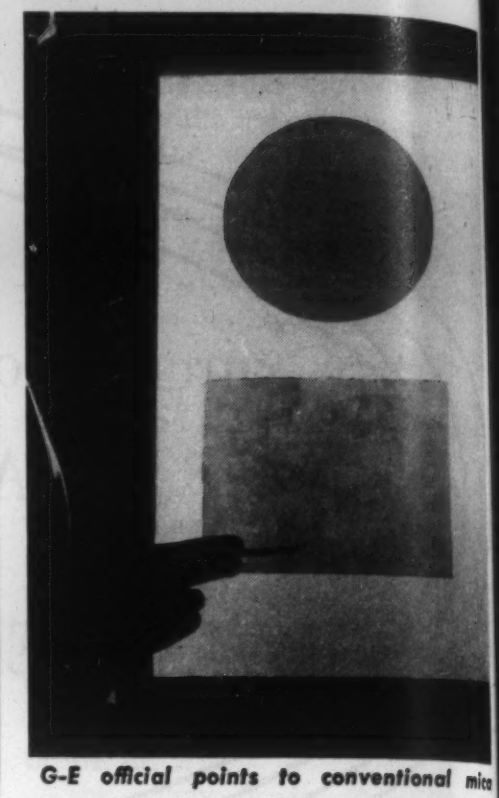

G-E official points to conventional mica electric insulation showing how mica splittings are overlapped and pasted to form a sheet. Circular sample is General Electric's new Micamat. The new product is more uniform and can be heated red-hot without disintegrating.

sandths to six-thousandths of an inch that has better dielectric strength than present machine- and hand-laid products. Greater uniformity of thickness and the absence of voids account for its improved properties.

Referred to as G-E Micamat, the new product is presently being pilot-planted in the laboratory of GE's Transformer and Allied Products Div. Commercial production is planned for the first quarter of 1952, when a commercial-size machine will be in operation at the General Electric Chemical Div. plant in Coshocton, Ohio.

The production of G-E Micamat may necessitate the reactivating of mica mines in the United States, it was forecast by Mr. Gibson, and it is possible that as production of Micamat expands, cost savings will result.

The utilization of domestic mica supplies promises help in alleviating a serious threat to the electrical industry due to the uncertainty of imports from abroad. Mica is listed as a strategic material.

Capable of being impregnated with resins and bonded to paper, glass and cloth for greater strength and improved electrical properties, G-E Micamat tapes and sheets can be used in heating devices, molded into shapes for motors and gener-

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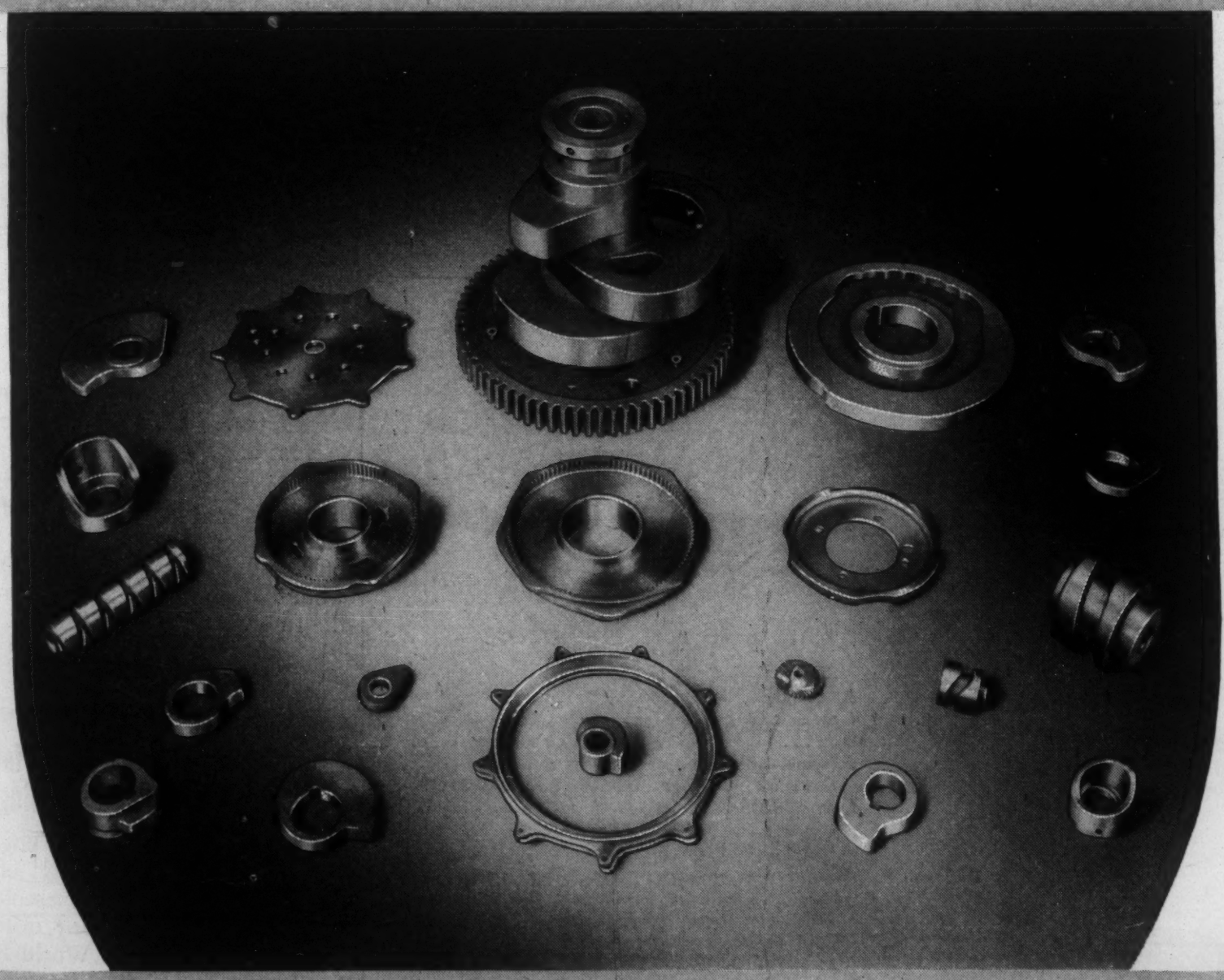

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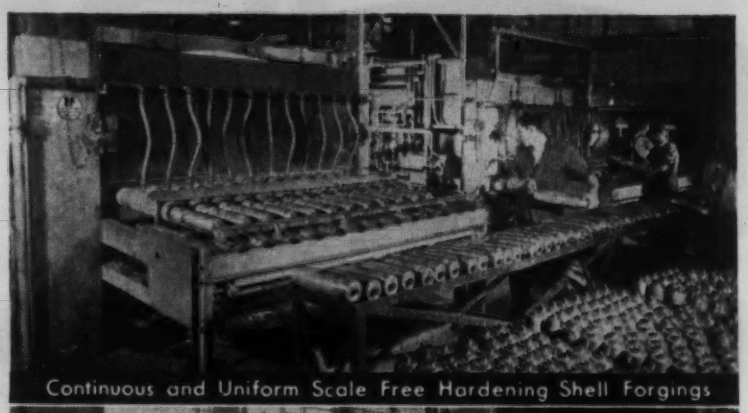

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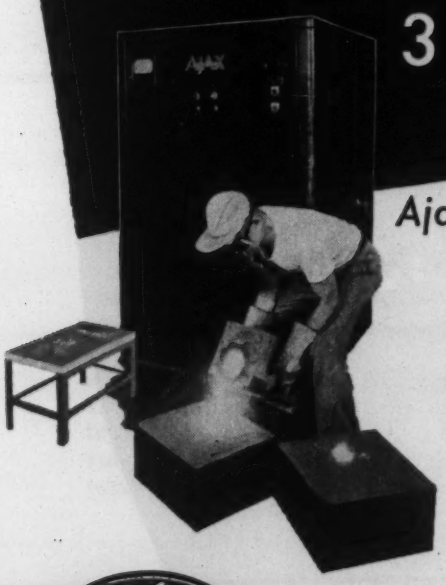

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142-S

News Digest

ators, or machine-wrapped on bars and cable. New laminates and tubing, constructed with G-E Micamat, having outstanding insulation resistance, are foreseen in the near future.

Chromium Stainless Steel Supply Exceeds Demand

The National Production Authority has removed chromium stainless steel from its Controlled Materials Plan for rationing metals. The action—the first of its kind under the present C.M.P. controls system—will result in almost complete decontrol of the metal. Users of chromium stainless steel will no longer need to present C.M.P. tickets when they order the metal from mills and warehouses.

N.P.A. took the action because steel mills can now turn out more chromium stainless steel than there is demand for. In December, for example, federal metals rationers invited manufacturers and other users to submit extra C.M.P. applications for 75 million rounds of chromium stainless for first quarter delivery. Mills had the capacity to produce this much additional metal in the first quarter, but they had not received C.M.P.-backed orders for it.

"We weren't very successful in moving the steel by this method," admitted one N.P.A. official. This official felt decontrol of the metal would tend to boost demand for it in the future.

Hydrostatic Testing Urged for Oil Well Casing and Tubing

H. G. Texter, chief field engineer of the Spang-Chalfant Div. of the National Supply Co., presented a paper of interest to many materials engineers at the Third World Petroleum Congress, held last year in Holland. Pointing out that mandatory requirements of American Petroleum Institute casing and tubing specifications do not insure a product that is able to withstand the forces to which it will be subjected, the author presents a good case for high pressure testing.

After discussing the API specifi-

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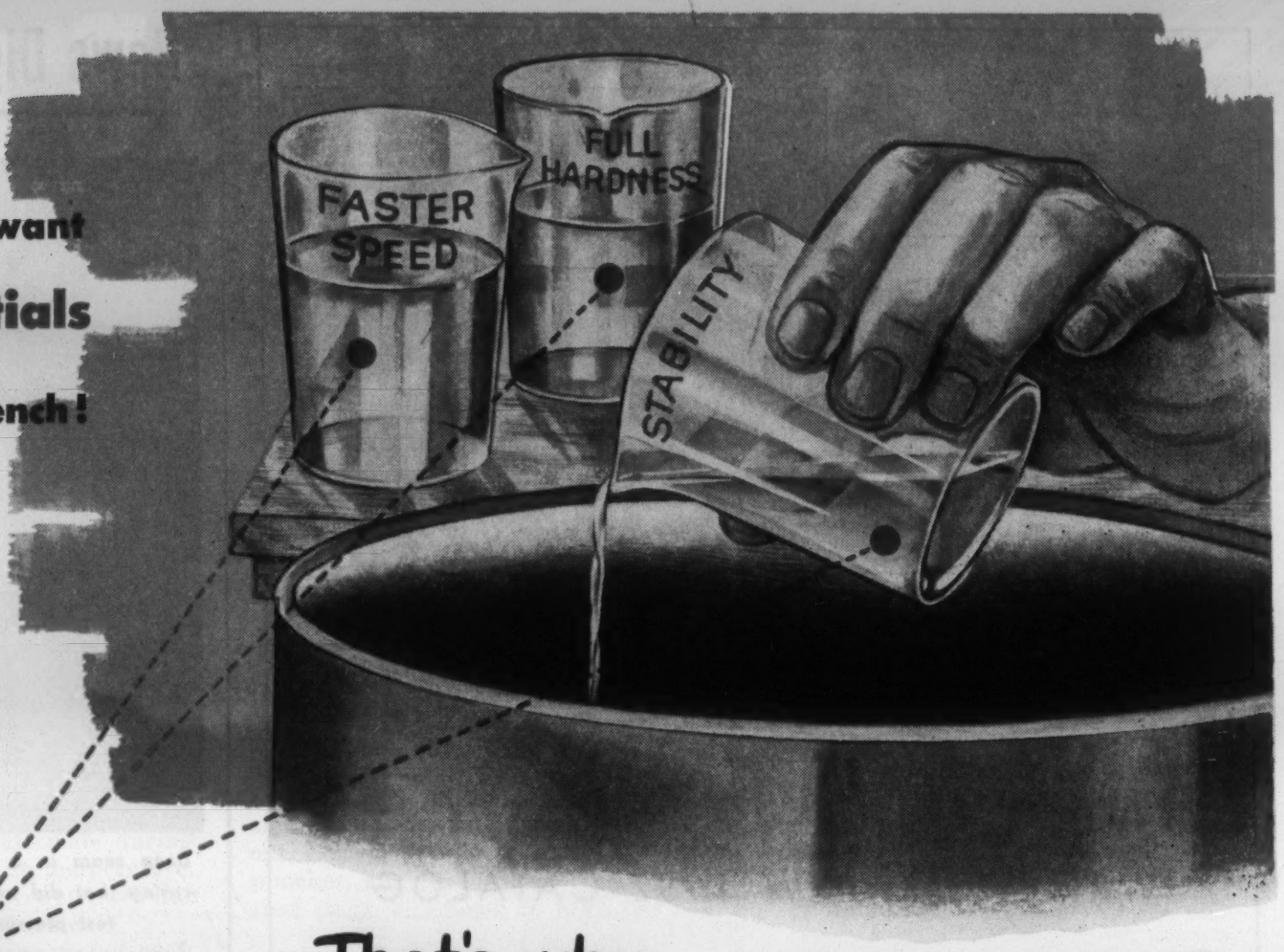

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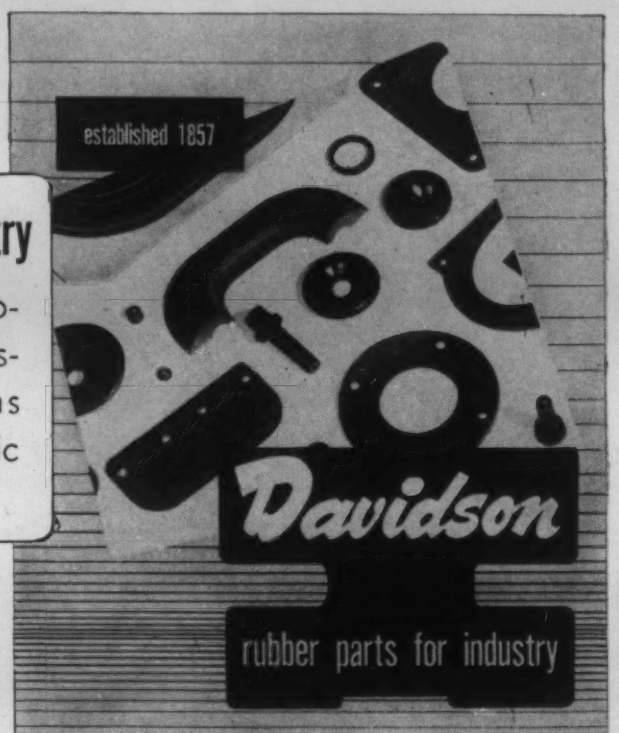

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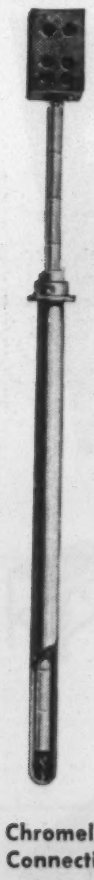

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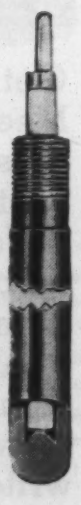

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Tubular Iron Constantan Thermocouple showing weld of hot junction.

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News Digest

Deep seam in a 7-in. O.D., 23-lb N-80 casing that did not fail under an internal-test pressure of 10,500 psi.

cations, he shows why compliance with them only indirectly proves the worth of the product. Only one requirement, the Mill Inspection Hydrostatic Test, is a direct proof of quality, and it does not go far enough. Taking exception to the description of "injurious defects", the paper explains why strict adherence thereto does not insure against failure, but leads to discarding good products. Data and photographic records are included to prove this point.

To avoid arguments on "injurious defects", and to insure proper performance, it is concluded that proof testing of each length is logical. Since tension testing, and especially collapse testing, would be too slow and expensive, internal pressure testing to 80% of the minimum yield strength is recommended.

The API has already set up alternative (not mandatory) high-pressure test figures, and the author asserts that pipe which withstands these pressures would stand up under comparable tension and collapse tests. If so tested, the user will not need to worry about "injurious defects", because the high-pressure test will find both visible and invisible ones.

Some casing and tubing defects, such as seams, pits, blisters, plug scores etc. may readily be seen, but their effect on performance cannot possibly be determined by visual inspection nor by determination of their dimensions. Others, such as

Tool Steel Topics

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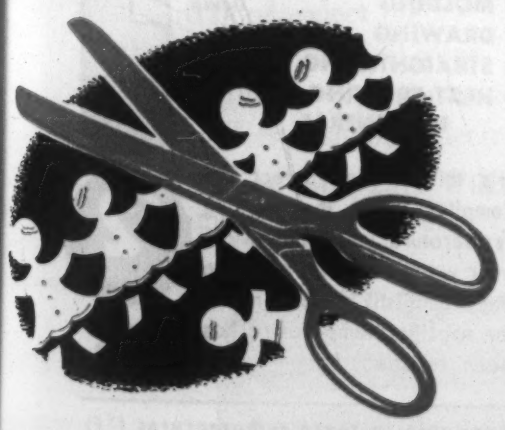
Our Tool Steel Engineer Says:

Double-Tempering adds service life to high-alloy tool steels

It's always best to double-temper tools made from the high-alloy tool steels such as the high-speed and hot-work types. These steels retain more austenite than tool steels with low-alloy content.

The first tempering relieves stresses in the martensite formed in the quench . . . and conditions the retained austenite so that it transforms to martensite during cooling from the tempering temperature. A second tempering relieves stresses due to the newly formed martensite.

Omitting a second temper on hot-work steels may lead to early failure by heat-checking. And with high-speed steels and high-carbon, high-chromium steels, such omission may result in abnormal sensitivity to grinding checks.



Scissors by the Million with Swaging Dies of 67 Chisel

A leading scissors-maker is an enthusiastic user of our 67 Chisel tool steel. He makes a variety of scissors, but specializes in the blunt-end kind that young folks use for paper dolls and such.

One of the cold-swaging dies of 67 Chisel has produced about 1,100,000 pieces. They have redressed the die five times since it was placed in service, each time removing about .003 in. And the shop reports that the die is good for plenty more.

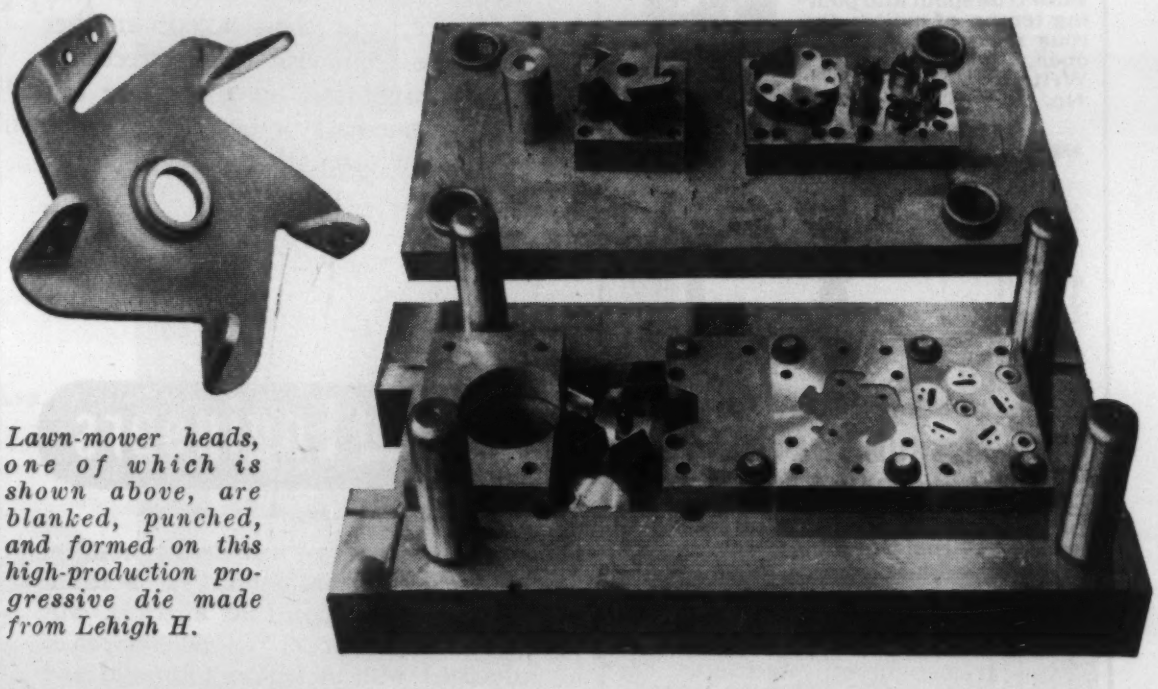
Here's a case that illustrates the satisfactory wear-resistance that can be obtained with a steel that's basically a shock-resisting type. 67 Chisel, in fact, is quite versatile. It's fine with all sorts of tools that have to withstand heavy impacts. And when carburized for extra-long-wearing service, this chrome-tungsten grade is first choice for master hobs used in cold-hobbing mold cavities.

Lehigh H Trims Costs on Lawn-Mower Heads

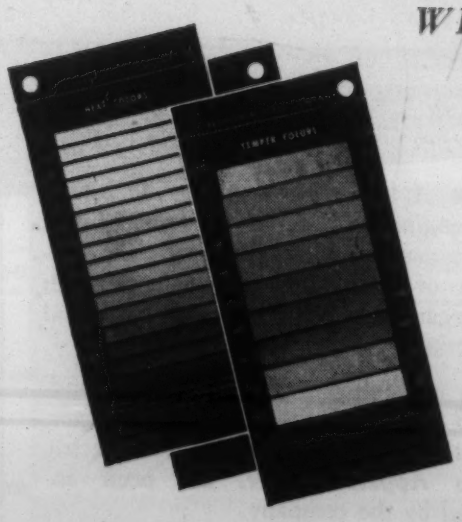
Giving your lawn that well-groomed look depends a lot on the precision of your trusty mower. The "head", for example, is a pretty important part of a lawn mower because it keeps those whirling blades in proper alignment.

These heads are produced by one large manufacturer on a progressive die of our Lehigh H tool steel which blanks, punches, and forms them from 3/16-in. steel strip. Hardened to Rockwell C-60, this die is mounted in a 200-ton press and turns out about 2000 pieces in an 8-hour shift. Costs are kept low by the long-wearing properties of this high-carbon, high-chromium tool steel.

Lehigh H is a good choice for this operation because it has the maximum wear-resistance necessary for long-run jobs involving severe service. And because it's air-hardening, it keeps distortion to a minimum during heat-treatment.



Lawn-mower heads, one of which is shown above, are blanked, punched, and formed on this high-production progressive die made from Lehigh H.



WRITE FOR THIS HANDY CHART OF HEAT AND TEMPER COLORS

Thousands of steel users and treaters depend on this convenient color guide to estimate the temperatures of heated steels. Printed in full, natural tones, the heat colors are on one side and temper colors on the other side. The lemon, orange, brown, blue and other colors that indicate the temperatures of heated steel are accurately reproduced. Both Fahrenheit and Centigrade figures are given for each color.

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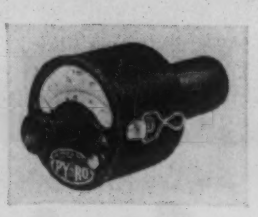

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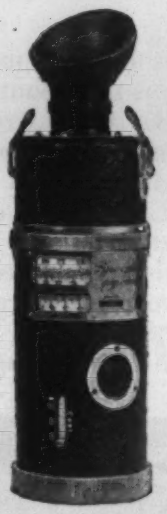

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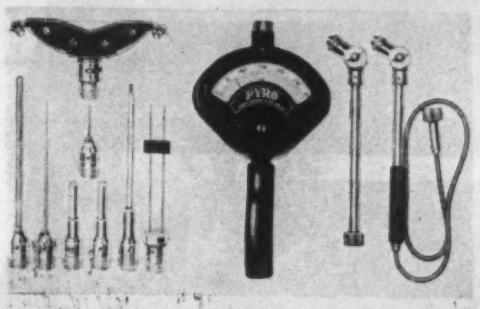

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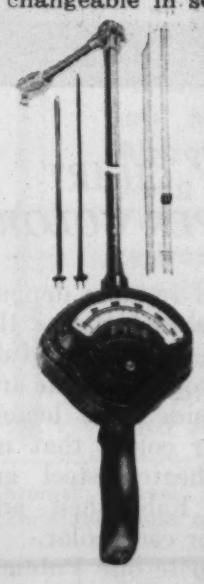

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News Digest

improper metallurgical treatment or accidental water quenching, cannot be found by any nondestructive test. These defects are usually the most fatal of all.

Defective tubes could be eliminated by any testing method that subjected the entire tube to stresses near the yield point of the metal, but only one of these—pressure testing—is economically feasible. It, fortunately, is relatively inexpensive and can be applied to each length. Also, internal pressure testing applies a stress in the direction of lowest physical properties, thus giving great assurance that lengths which pass this test would pass tension or collapse tests of comparable intensity.

To the author it seems utterly absurd to reject a tube because of a surface imperfection which has an immeasurably small effect on performance, and then accept another tube free from visible imperfections, which might fail on a pressure test of only one-half or one-third of the yield-point strength.

News of Engineers

Kenneth C. Towe was elected president of American Cyanamid Co. at a recent meeting of the board of directors. Mr. Towe, a director of several companies associated with American Cyanamid and its principal subsidiaries, succeeds the late *Raymond C. Gaugler.*

Directors of the William F. Clapp Laboratories, Inc. have elected *A. P. Richards* president and director to succeed Dr. *William F. Clapp,* who died recently.

John A. Borman has been appointed chief engineer of the Baker-Raulang Co. Mr. Borman will have charge of administration of the Engineering Dept., both with regard to new development work and production engineering.

The appointment of *George E. Goodrich* to the position of assistant manager, Industrial Dept. of Westinghouse Electric Corp.'s Apparatus Div. has been announced by the company.

E. W. Claar has been named manager of Eastern Clay Products Dept., International Minerals & Chemical Corp.

The election of *Howard L. McGregor, Sr.* as chairman of the board and *Howard*

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163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
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FREE —Tempil° "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

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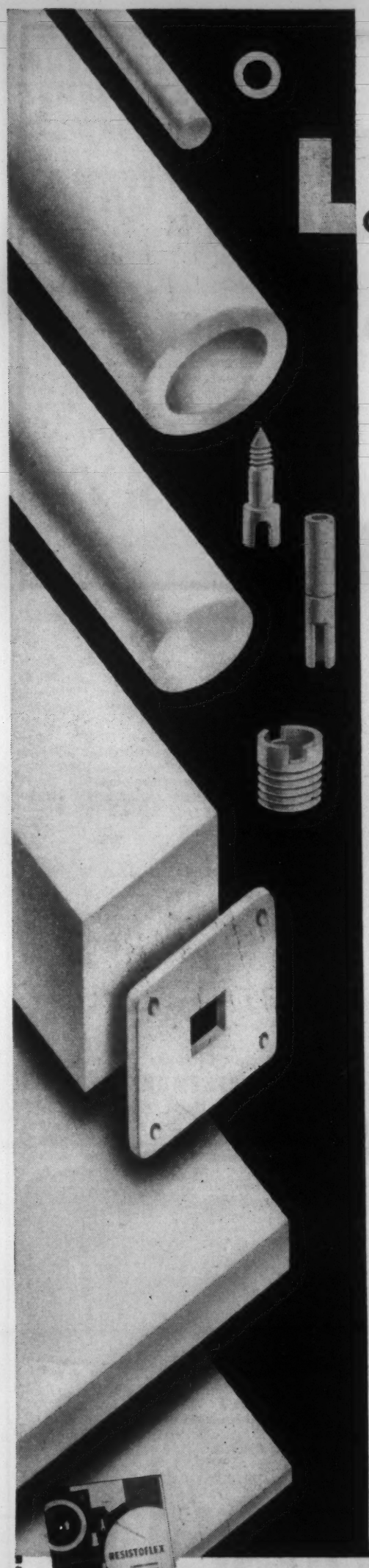

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News Digest

L. McGregor, Jr. as president has been announced by National Twist Drill & Tool Co.

James William Phillips has been appointed to The Riverside Metal Co.'s Special Products Div. Mr. Phillips will serve as a development engineer.

The appointment of *T. F. Fleming* as general manager has been announced by Morrison Engineering Corp. Formerly, Mr. Fleming was supervisor of the Heat Treating Dept., National Screw & Manufacturing Co.

W. E. Brainard has been elected president and director of Arcrods Corp., replacing *J. H. Humberstone,* who has become chairman of the board.

Two new officers were added to the management group of Topflight Tool Co., Inc. *Clarence H. Krout* was named vice president in charge of production, research and development, and *Bryn T. Morgan* has been advanced to the position of vice president in charge of industrial and new product sales and promotion.

Sharon Steel Corp. has announced the promotion of *Thomas J. Moore, Jr.* to the post of general manager, Brainard Steel Div.

E. M. Converse, senior vice president of Dearborn Chemical Co., has retired after almost a half century of service.

William M. Wallace has been appointed an assistant to the vice president of Allis-Chalmer's General Machinery Div., according to a recent company announcement. Also announced by the company was the retirement of *Hans P. Dahlstrand,* dean of the ranking American steam turbine engineers, who retired as director of steam turbine engineering after 47 years of service with the firm.

General Electric Co. has announced the following changes within its organization: *John L. McMurphy* has been appointed general manager of the Plastics Dept.; *Sam L. Brous* was named general manager of the Chemical Materials Dept.; *James W. Raynolds* is now marketing manager of the Chemical Div.; Dr. *Alphonse Pechukas* has been named engineering manager of the Chemical Div.; *Earl W. Cunningham* was appointed general manager of the Industrial Heating Dept.; and *William E. Ruder,* one of the country's leading authorities in the field of permanent magnets and magnetic materials, will retire from the company's Research Laboratory after more than 44 years of service. Dr. *Karl B. McEachron,* manager of the Laboratories-Engineering Dept. of the company's Transformer and Allied Products Div., was initiated into Eminent Membership by the Eta Kappa Nu Assn. Only five other distinguished scientists have previously been inducted into the Association, an honor society for the electrical engineering profession. Three engineers in the Transformer and Allied Products Div. have been awarded the

"You may have to stand outside!"

REMEMBER Aesop's fable of the camel and his master--how the kind master allowed the shivering beast to put into the tent first his head, next his shoulders, then his forelegs!

And then the camel said, "Master, I think I ought to come wholly inside," and crowded in. Immediately he said, "There is hardly room for us both, so I think it would be better for you to stand outside so I can turn around and lie down." And without further ado, the camel kicked the man out and took the entire tent.

Men have heard this story for 2,500 years--repeatedly have seen how it illustrates what happens when one man or group of men gain power over others. Men saw it happen in Italy and Germany when Mussolini and Hitler took over. Men saw it happen in Russia.

Even here in America a similar trend is evident. Powerful influences overlook no opportunity, through political manipulation, central controls and bureaucratic regulations, to intrude more and more in our private lives. The situation demands continual, alert watchfulness by all citizens who believe in individual liberty and freedom, to prevent this camel of big government from creeping further into the tent. Before we realize it, "we, the people," the master, may find ourselves "standing outside." In America it is government, which is the servant of the people.

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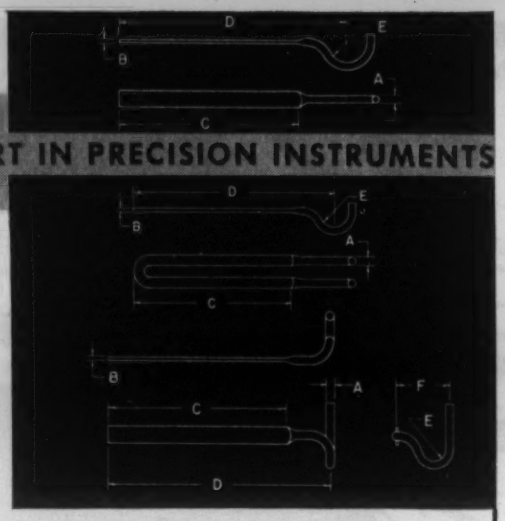
The steel industry is using all its resources to produce more steel, but it needs your help and needs it now. Turn in your scrap, through your regular sources, at the earliest possible moment.



SMALL PARTS PLAY A **BIG** PART IN PRECISION INSTRUMENTS

HERE, for example, are typical sliding contacts now being supplied by us to manufacturers of precision potentiometers. PALINEY* #7, Ney-developed precious metal alloy from which they are made, has just about ideal physical and electrical properties for this service. It has very high tarnish resistance and is unaffected by most industrial atmospheres. Its hardness, controlled by simple heat-treatment, is especially suited to use with the nickel-chrome type of resistance wire, as well as our own high strength NEY-ORO G precious metal resistance wire. Potentiometers so equipped, have demonstrated service life of up to 20 million cycles with excellent sustained linearity and low noise level.

This is just one of many new and important precious metal alloy developments of interest to instrument and electronic engineers detailed in our new Technical Bulletin #R-12. Write for your copy.

*Reg. T. M. J. M. Ney Co.

THE J. M. NEY COMPANY, 105 Elm Street, Hartford 1, Connecticut
Specialists in Precious Metal Metallurgy Since 1812.

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Stainless Steel and Aluminum Parts for Gas Turbine Aircraft Engines.

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News Digest

Mathewson Gold Medal for outstanding achievement in the field of metallurgy. Recipients are: *Cecil G. Dunn, Franklin W. Daniels, Michael J. Bolton* and *Fabian Lionetti.* Mr. Lionetti is currently an instructor in biochemistry at the Boston University School of Medicine. The awards were made by the American Institute of Mining and Metallurgical Engineers.

Union Carbide and Carbon Corp. has announced the death of *James A. Rafferty,* vice president and director of the company.

William A. Irvin, former president of the United States Steel Corp., recently died after a long illness.

American Cyanamid Co. has announced the death of its president, *Raymond C. Gaugler.*

The Ajax Electric Furnace Corp. has announced the death of its vice president, *James R. Wyatt.*

News of Companies

Weirton Steel Co., division of *National Steel Corp.,* has put into operation a detinning plant which it says is the only one of its kind in this country owned and operated by a steel company. The plant will have a capacity for the recovery of 300,000 lb of tin and 30,000 tons of high quality scrap per year. The raw material for the plant consists mainly of steel scrap produced in Weirton's tin mills. Some tin scrap also will be added from the outside for processing. Company officials say the recovery of tin from the new plant will be supplemented by the salvage of scarce metal from chemical solutions used in the production of tin plate by the electrolytic process. Facilities for the latter purpose were installed in 1942.

On the occasion of its golden anniversary, the *Chicago Metal Hose Corp.* has announced the change of its corporate name to *Flexonics Corp.*

DeVilbiss Co. has been awarded a Certificate of Cooperation from the Economic Cooperation Administration for the company's participation in the agency's technical assistance programs.

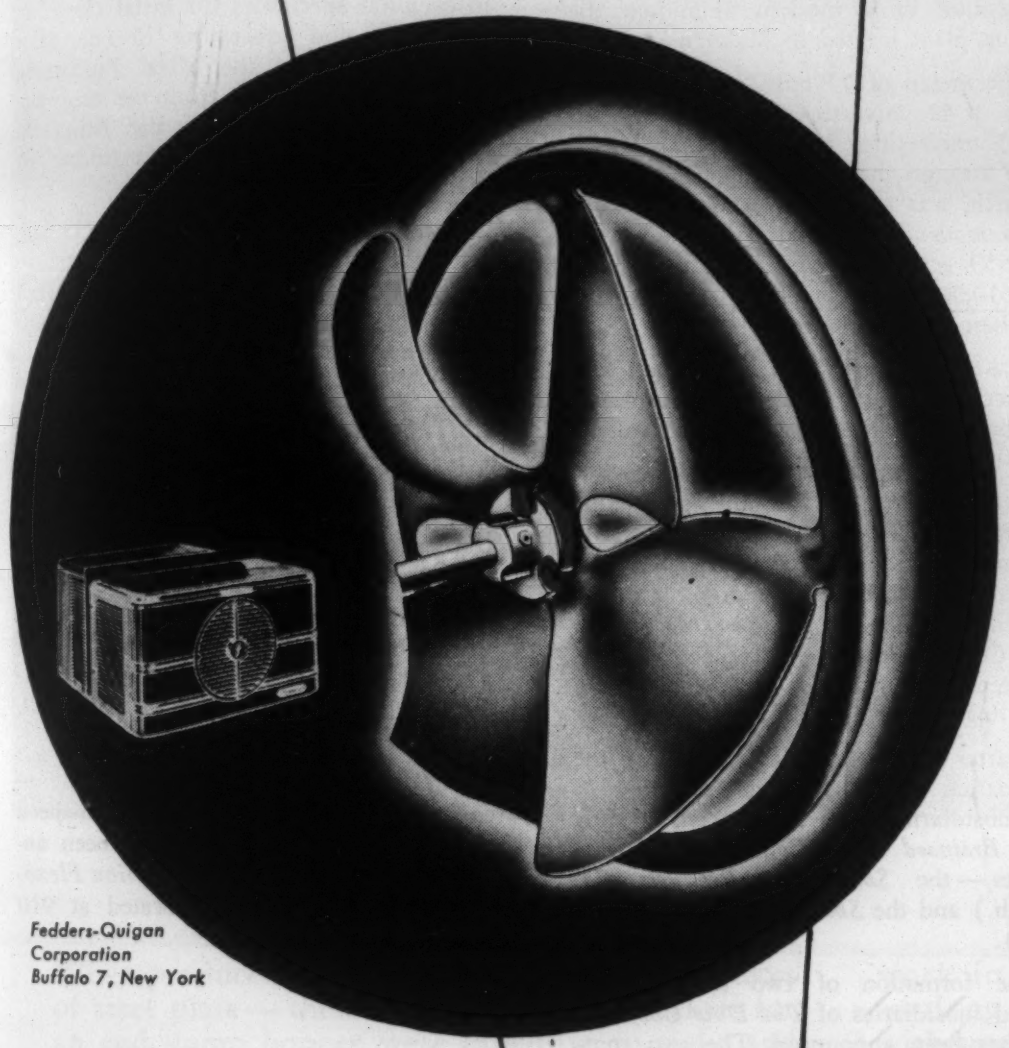
Allegheny Ludlum Steel Corp. has changed the name of its sintered carbide production and sales units from *Carbide Alloys Div.* to *Carmet Div.*

Titeflex, Inc. has announced the establishment of an Electronics Div. to coordinate the manufacture and sale of flexible

OIL RESISTANCE

LOW COMPRESSION SET

These properties of neoprene make a better ROOM AIR CONDITIONER

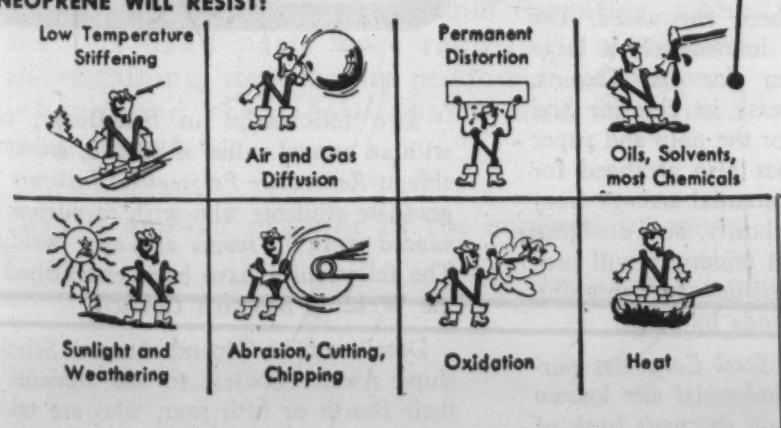


Fedders-Quigan Corporation Buffalo 7, New York

Noise is reduced to a minimum in this window-type room air conditioner by a bonded-neoprene fan hub. The resilient neoprene vibration pad is permanently bonded on one side to a zinc die-casting which is attached by a set screw to the motor shaft. On the other side, it is bonded to an aluminum washer that is fixed to the fan by three rivets. The neoprene pad between the two effectively dampens vibration and prevents transmission of noise.

Oil resistance and low compression set are only two of the properties of neoprene that make it the logical choice for this vital component part. Du Pont neoprene resists deterioration from ever-present grease and oil. And neoprene's low compression set means the pad will retain its vibration dampening characteristics throughout its long life. In this new-type fan hub . . . as in hundreds of other resilient parts and products . . . the use of properly compounded neoprene solved a tough design problem.

PROPERLY COMPOUNDED NEOPRENE WILL RESIST:



Send for the "Neoprene Notebook." Each issue shows new, unusual applications of neoprene . . . new products . . . improved designs. Use the handy Reader Service card or write us directly. We'll add your name to our mailing list . . . and send information on other uses for neoprene and sources of supply, if you desire. E. I. du Pont de Nemours & Co. (Inc.), Rubber Chemicals Division A-3, Wilmington 98, Delaware.

DU PONT

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Better Things for Better Living . . . through Chemistry

NEOPRENE

The rubber made by Du Pont since 1932

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If you feel that you can meet these specifications, please write, including your educational and working background, age, marital and martial status, references and what you expect in the way of salary. If possible, include samples of any of your published writings.

Address all communications to:

T. C. Du Mond, Editor
MATERIALS & METHODS
330 W. 42nd St.
New York 36, N. Y.

News Digest

and rigid waveguides, electronic parts and special equipment.

Construction of a major unit for the production of polyethylene resins has been announced as an addition to the Texas City plant of *Carbide and Carbon Chemicals Co.*, a division of *Union Carbide and Carbon Corp.*

Universal Die Casting & Manufacturing Co. has announced its entry into the aluminum die casting field through the acquisition of a modern aluminum die casting plant located in Malvern, Ark.

The award of 75 post-graduate fellowships to 47 universities, and grants-in-aid to 15 universities to "stock-pile" knowledge through the support of fundamental research, was announced by *E. I. du Pont de Nemours & Co., Inc.* They are for the 1952-53 academic year. An authorization of $510,000 was provided by the company for these and other awards.

Pittsburgh Plate Glass Co. has announced plans to purchase a factory at Shelbyville, Ind., as a manufacturing facility for its new Fiber Glass Div.

Further expansion in the production facilities of *The American Welding & Manufacturing Co.* was made known with the announcement of the signing of an agreement with *The Warren Machine & Die Co.*, whereby the latter becomes the Warren Machine & Die Div. of American Welding.

Sharon Steel Corp. has announced the liquidation into the parent company of its subsidiaries, *The Niles Rolling Mill Co., Brainard Steel Co.*, and its warehouses — the *Sharonsteel Products Co.* (Mich.) and the *Sharonsteel Products Co.* (Pa.).

The formation of two new wholly-owned subsidiaries of *The Dow Chemical Co.* has been announced. The two companies, *Dow Chemical Inter-American Ltd.* and *Dow Chemical International Ltd.*, represent a move to extend Dow's international activities.

Plans for a 5 million dollar plant expansion program for *Hooker Electrochemical Co.* have been announced. The company will begin immediately a large construction program for its Tacoma, Wash. plant to increase its chlorine and caustic soda output for the pulp and paper industries. Hooker has also arranged for the purchase of a substantial acreage from the Tacoma Port Authority, and dredging operations soon to get underway will provide deep water facilities for shipping chlorine and caustic soda by barge.

Allegheny Ludlum Steel Corp. has purchased the 160-acre industrial site known as "Murphy's Flats" on the west bank of the Allegheny River. The site was bought for further expansion of the company in the Pittsburgh district.

The De Laval Steam Turbine Co. has announced that they have completed installation of the Meehanite process controls in their foundry. The foundry produces about 25 tons of castings daily for such company products as centrifugal and rotary pumps, steam turbines, centrifugal blowers and worm gear speed reducers. De Laval has also announced the formation of a subsidiary corporation, the *De Laval Turbine Pacific Co.*, with headquarters in the new building at Main and Folsom Sts., San Francisco.

The combination of *Sharples Chemicals* with the *Pennsylvania Salt Manufacturing Co.* through an exchange of common stock has been effected. Pennsylvania Salt Manufacturing Co. has also announced the consolidation of all sales and service in chemical specialties for metal cleaning, fabricating and processing in one sales department, called the Metal Processing Dept. Another release from the company announces the receipt of the American Institute of Management's Certificate of Management Excellence.

Cece Steel Products Corp. has established six 2-year engineering scholarships divided equally between the University of Illinois, Purdue University and Illinois Institute of Technology. Each scholarship is for the junior and senior years and is worth $1,000.

Clippard Instrument Laboratory, Inc. has announced that it will move, on April 1, to a modern new plant it is now constructing at 7350-7390 Colerain Ave. between Mt. Airy and Groesbeck, Ohio.

A half-million dollar expansion program which will provide new facilities for the *Capacitor* and *Metals & Ceramics Divs.* was recently announced by *P. R. Mallory & Co.*

The formation of a new company to engineer, manufacture and sell high-speed automatic stamping presses has been announced. To be known as *Precision Flexopress Corp.*, the firm is located at 910 Baymiller St., Cincinnati.

News of Societies

Two fellowships in metallurgy, each with an annual value of $3,500, are available at *Rensselaer Polytechnic Institute* for graduate students who wish to pursue advanced work in seams and spot welding. The fellowships have been established by the Welding Research Council.

Details of its Second Annual Scholarships Award Contest to aid students in their fourth or fifth year, who are taking subjects under the general category of Tool Engineering, have been announced by the *American Society of Tool Engineers.* Five awards will be made, as in 1951. To be eligible, students must be taking one or more of such subjects as

PRODUCT DESIGN STUDIES • NO. 37

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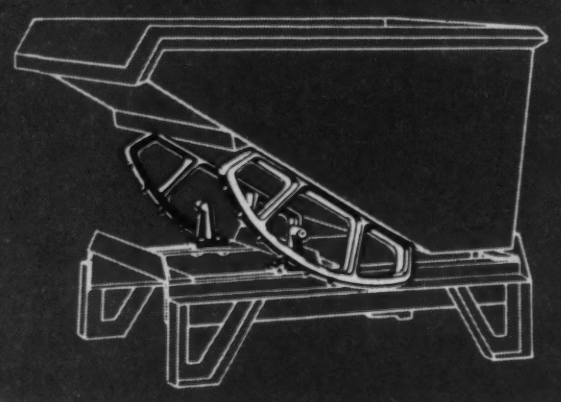
HOPPER PARTS

CAST STEEL
HOPPER PARTS

- Cost Reduced 23%
- Weight Reduced 8%
- Longer Life

with **STEEL CASTINGS**



When produced as weldments—from thirteen pieces of steel plate — these rockers and stop brackets for an end dump hopper were expensive to make and presented certain production problems.

Conversion to *foundry engineered* steel castings reduced the cost of these parts $5.48 per hopper; cut their weight from 117 lbs. to 107 lbs., through better weight-strength ratio; simplified production by making parts interchangeable (formerly, right and left hand parts were required); eliminated all machining, stepping up production of hoppers; lengthened the life of parts, and improved their appearance.

* * *

Here is another example of the engineering teamwork in design and redesign of parts which is resulting in lower costs and greater serviceability with steel castings.

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by the Steel Founders' Society of America.

Keep The Scrap Coming Back . . .

There is a serious shortage of iron and steel scrap. Your company can help insure the continued high production of all metal products by getting your scrap into the hands of your scrap dealer. Will you do what you can to help . . . *now*?

STEEL FOUNDERS' SOCIETY OF AMERICA

920 Midland Building **Cleveland 15, Ohio**

Design and Build With Steel Castings

WOOD

may be the answer to your problem

. . . if so

GAMBLE BROTHERS

is the key to that answer . . .

More than fifty years of leadership in wood-engineering back up Gamble Brothers' offer of assistance in meeting design and redesign problems. In that time Gamble Brothers has many times shown the way to make wood serve better than it had ever served before . . . and to make wood serve well where it had *never* served before.

Implementing this extensive know-how, Gamble Brothers has complete facilities for producing your needs in hardwood. Currently, it supplies to many industries, and to the defense program, a wide assortment of wood parts in solid or laminated hardwoods, roughed out or finished, flat, turned, shaped, or curved . . . even plastic-faced!

Accept Gamble Brothers' offer of engineering assistance. It entails no obligation whatever. If your problem is merely where to procure dependable wood parts, Gamble Brothers is certainly your answer. Write today.

Engineered Wood Parts in Southern and Appalachian Hardwoods, Walnut or Mahogany

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News Digest

metal processing, tool design, plant layout, inspection, or advanced courses in manufacturing processes in institutions accredited by the Engineers Council for Professional Development of the Society. Of the five scholarships of $300 each, four will be awarded to students in the U. S. and one to a Canadian student.

The Resistance Welder Manufacturers Assn. has announced the election of J. R. Barefoot, Jr. as president for the coming year.

Election of Harvey T. Harrison, vice president, The Duraloy Co., as president of the *Alloy Casting Institute,* has been announced. Mr. Harrison, until recently vice president of the Institute, has been succeeded by R. H. English, chief metallurgist, National Alloy Steel Div., Blaw-Knox Co., who has served as a director and as chairman of the Institute's Technical Research Committee.

Harold V. Atnip, chief draftsman of the Body Design Dept., Chrysler Corp.'s Engineering Div., has been named president of the *American Society of Body Engineers*. He succeeds Harry G. Garman, of the Fisher Body Div., General Motors Corp. Other officers installed were: Kenneth E. Coppock, Fisher Body, vice president, and Glenn F. Doyle, Ford Motor Co., secretary.

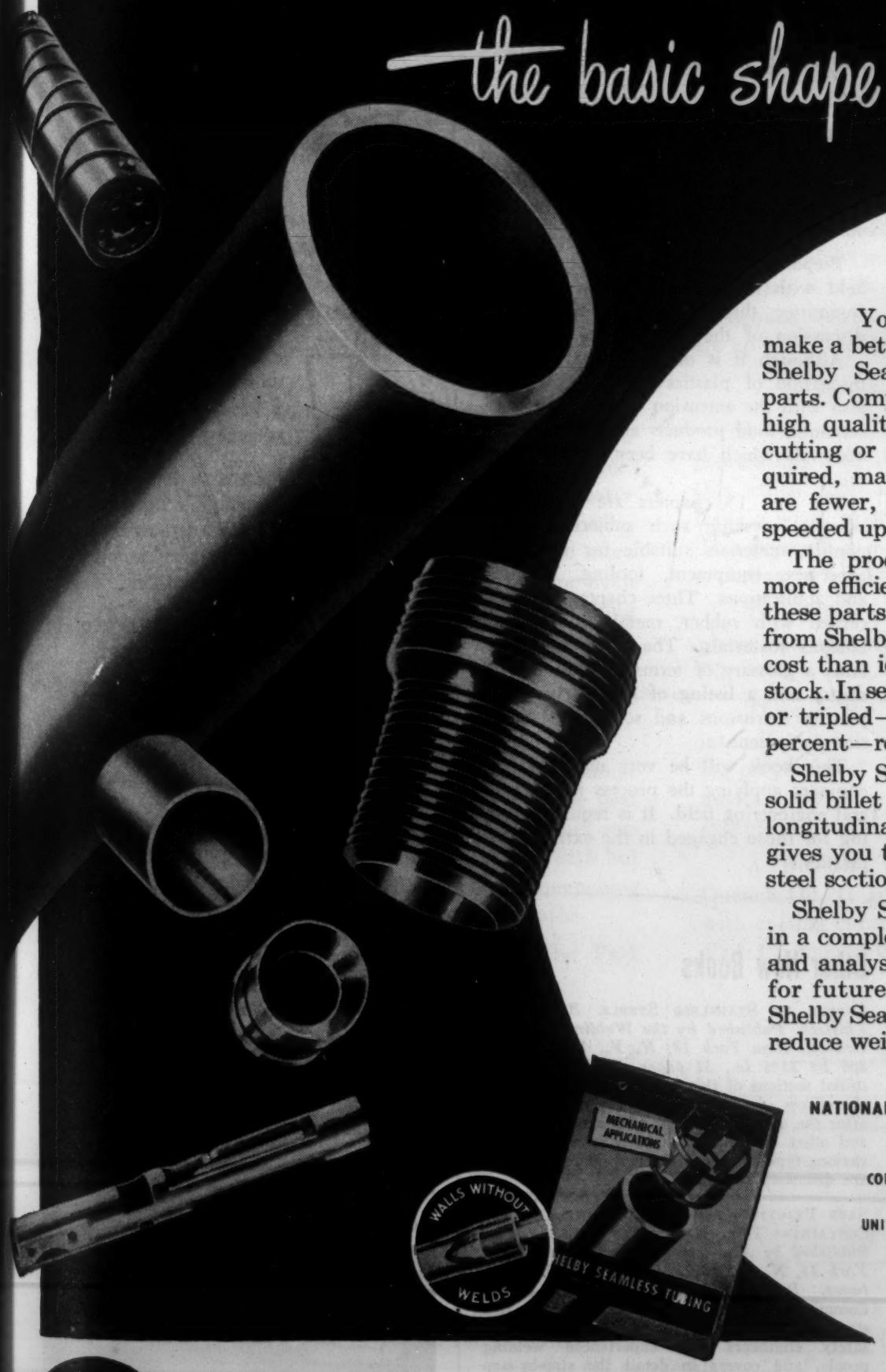
Armour Research Foundation of *Illinois Institute of Technology* is currently offering a number of industrial research fellowships in physics, chemistry, metallurgy, ceramics, engineering mechanics and electrical engineering to begin in September, 1952. Recipients of the fellowships will attend the Institute half-time and work in the Research Foundation half-time in a graduate program leading to advanced academic degrees. Awards are made on a competitive basis.

The Society of Plastics Engineers, Inc. has announced the election of the following new officers: William O. Bracken, Hercules Powder Co., of the Philadelphia Section, president; Walter Oelman, Standard Molding Corp., of the Dayton Section, vice president; Don F. Hoffman, Evans-Winter-Hebb, Inc., of the Detroit Section, treasurer; and John LaBelle, Koppers Co., Inc., of Eastern New England Section, secretary.

R. Wolcott Hooker, vice president in charge of sales, Hooker Electrochemical Co., was elected president of the *Compressed Gas Assn., Inc.* Mr. Hooker, who succeeds Daniel Mapes, vice president, Walter Kidde & Co., was also reelected president of the Chlorine Institute for the fourth successive year. Other officers of the Association include: John H. Mills, director of priorities, Bridgeport Brass Co., first vice president; and R. J. Thompson, manager of the Kinetic Chemicals Div., E. I. du Pont de Nemours & Co., Inc., second vice president. Franklin R. Fetherston was reelected secretary and treasurer

When you use Shelby Seamless

the basic shape is already made



You can save time, money and steel—and make a better automotive product—when you use Shelby Seamless Tubing for hollow cylindrical parts. Compared to solid bar stock or forgings, this high quality seamless tubing requires much less cutting or boring. Since fewer operations are required, man and machine hours are less, rejects are fewer, production of all automotive parts is speeded up.

The products shown here are typical of this more efficient method of manufacturing. Some of these parts are quite complex, but each was made from Shelby Seamless Tubing, faster and at lower cost than identical parts machined from solid bar stock. In several cases production has been doubled or tripled—costs savings have run as high as 50 percent—rejects have been reduced to zero.

Shelby Seamless Steel Tubing is pierced from a solid billet of quality steel. As a result, there is no longitudinal weld to weaken the tube. This process gives you the strongest, most dependable tubular steel section that money can buy.

Shelby Seamless Steel Tubing is manufactured in a complete range of diameters, wall thicknesses and analyses to meet every need. When you plan for future automotive applications, remember Shelby Seamless for its ability to increase strength, reduce weight and cut your production costs.

NATIONAL TUBE DIVISION, UNITED STATES STEEL COMPANY
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UNITED STATES STEEL

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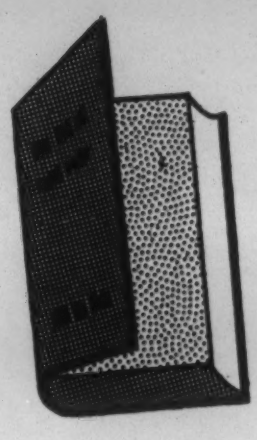

BOOK REVIEWS

Extruding Metals and Nonmetals

EXTRUSION OF PLASTICS, RUBBER AND METALS. *By Herbert R. Simonds, Archie J. Weith and William Schack. Published by Reinhold Publishing Corp., New York 36, N. Y., 1952. Cloth 6¼ by 9¼ in., 454 pages. Price $10.00.*

Prepared by three authorities in the field with the collaboration of a special committee, this book is a comprehensive discussion of the extrusion of materials.

Although it is devoted primarily to a discussion of plastics extrusion, it deals also with the extrusion of rubber, metals, ceramics, food products and several other materials which have been fabricated by this process.

The first 15 chapters are devoted to plastics, covering such subjects as economics, materials suitable for extrusion, processes, equipment, tooling, products and applications. Three chapters are concerned with rubber, metals and miscellaneous materials. The book also contains a glossary of terms used in the industry and a listing of manufacturers of plastics extrusions and sources of extrusion equipment.

This book will be very useful to the engineer applying the process in the general engineering field. It is required reading for those engaged in the extrusion of plastics.

Other New Books

COPPER IN STAINLESS STEELS. *By Helmut Thielsch. Published by the Welding Research Council, New York 18, N. Y., 1951. Paper, 8¼ by 11¼ in., 31 pages. Price $1.00.* The initial sections of this bulletin discusses briefly the effects of copper in ordinary steels. Then, after the additional effects of nickel, chromium and other elements have been introduced, the various types of copper-bearing stainless steels are discussed in detail.

SAFE PRACTICES FOR WELDING AND CUTTING CONTAINERS THAT HAVE HELD COMBUSTIBLES. *Published by American Welding Society, New York 18, N. Y., 1952. Paper, 6 by 9 in., 12 pages. Price 50¢.* Prepared by the AWS Committee on Safety Recommendations, this standard reflects the best recommendations of safety engineers and experienced welding people, and covers in detail the step-by-step procedures to take in preparing various containers prior to welding or cutting.

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foolproof bond for any product finish

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PHOSPRAY

a cold spray bonding solution applied with ordinary spray equipment.

Phospray eliminates cleaning, rinsing, drying and other preliminary preparation.

Phospray dries "dust free" immediately, ready for application of final finish.

Phospray can be cut with thinner as high as 3 to 1 without reducing effectiveness.

Phospray has been thoroughly field tested to govt. specs. under conditions of humidity, salt spray, etc.

Phospray cuts processing time, reduces finishing costs, and provides an easy sure-fire bond for organic finishes on almost any metal.

METAL FINISHING SPECIALISTS

Phospray is made and guaranteed by Du-Lite, the metal finishing specialists.

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MIDDLETOWN, CONN.

Send me a sample of Phospray... ☐
Send more Phospray information.. ☐
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Du-Lite

METAL FINISHING SPECIALISTS

Tests show New Quench Oil has Intensified Triple Action

A new accelerated quenching oil has been developed that gives (1) rapid heat removal with faster cooling rate in the hardening range, this results in higher and deeper hardness; (2) slow cooling below the hardening range, thus minimizing distortion; (3) greater stability due to special anti-oxidants, for longer life and bright quenching properties.

To better illustrate the manner in which this triple action quenching oil accomplishes this higher quenching efficiency, it will be well to show the three stages of cooling as observed when steel is quenched in oil from a red heat. These stages are:

A. Formation of a vapor film at the steel surface; cooling is accomplished by conduction and radiation through this vapor film and is relatively slow.

B. Direct contact of the oil with the metal surfaces, causing a boiling action which continually dissipates the vapor film formed and results in rapid cooling.

C. After the metal has been cooled to the boiling point of oil, vapor is no longer formed; cooling is by conduction and convection, and the metal slowly cools to the temperature of the oil.

It is apparent that any improvement in the cooling power of oil in stages A and B would be most desirable. This can be compared to the brine quench which is used instead of water. Brine has a wetting action that completes the quench faster than fresh water, which "takes hold" only in spots, causing non-uniformity. Salt brine solutions provide deeper and more uniform hardnesses. This results in deeper and more even hardnesses. It seems logical to attempt to do this same thing with oil. The mineral intensifiers added to this Triple A Quenching Oil act in this manner.

Practical Application of Quench Curves to Hardening Steel

The improvement of oils so as to effect this desired change in the cooling characteristics has been attempted in the past by blending mineral oil with animal oils, but the product was prone to become rancid, or to decompose on contact with hot steel. These blends were also unsatisfactory as quenching mediums for steel treated in certain types of salt baths.

Developed in the Research Laboratory of the Park Chemical Co., the Park Triple A Quench Oil, a blend of specially refined mineral oils, cools steel faster in the upper temperature range by shortening the duration of vapor stage (A) and intensifying the action of boiling stage (B). Heat removal in stage (C) is slow and uniform. Thus, the best surface hardness and depth of hardness penetration are achieved with no danger of cracking or distortion.

Extremely stable, this new accelerated quenching oil may be used as a quench from any heat treating medium without fear of rancidity, oil breakdown, or change in quenching efficiency. Further, Park Triple A Oil is especially suitable for obtaining the maximum uniform oil-quenched hardenability from low and medium alloy steels.

Results of the improvement are shown in chart below showing actual hardnesses in quenched pieces. There is a 16% surface hardness increase with Park Triple A Oil over a good grade of straight mineral oil. The effect would be greater when comparing it with some of the poorer grades of oil used for quenching. Center hardnesses of the one-inch diameter piece are up 14%. Lighter sections would show even more increases.

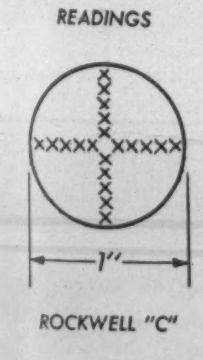
Bright Quenching and Stability

A very crucial and costly problem in the carbo-nitriding process has been the cleanliness of work after oil quenching. Oils which deteriorate rapidly or were originally unsuitable leave a sooty carbonaceous film on the surface of the work. This presents a difficult cleaning problem when followed by a plating or welding operation.

This difficulty, when not the fault of the furnace atmosphere, can be corrected by the use of Park Triple A Quench Oil.

Through the use of anti-oxidant additives and mineral intensifier it has been possible to prolong the bright quenching properties of good clean oil. Underwood Oxidation experiments have proven Park Triple A Quench Oil to have exceptional stability and long life.

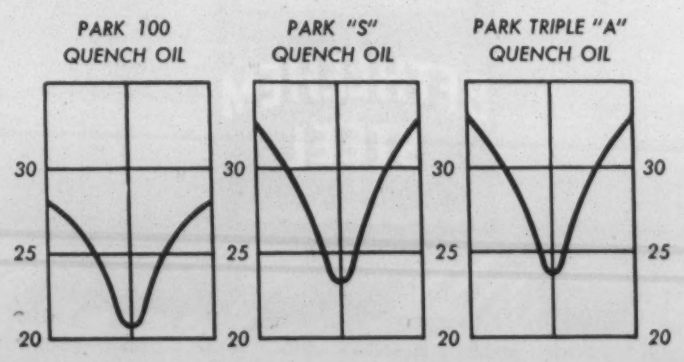
A Bulletin, #F8, was prepared on Park's Triple A Quench Oil. It gives you a complete description of this oil with cooling curves, production data and photographs. Write Park Chemical Co., 8079 Military Ave., Detroit 4, Mich.



STEEL: S.A.E. 1045 1" ϕ x 2"

TREATMENT: 1550° F. IN NEUTRAL SALT QUENCH IN OIL AT 75° F.

HARDNESS: ROCKWELL "C" READINGS ACROSS INNER SURFACES OF SECTIONED SAMPLES



Transverse hardness Rc taken on 1" round SAE 1045 steel two inches long. Quench from Park's Nu-Sal neutral salt at 1550°F. into three types of quench oil, Park's No. 100 Oil (straight paraffin), Park's "S" Oil (compound with animal oil), Park's Triple A Oil. Oil temperatures 75° F.

(Advertisement)

Accurate threads for smooth fit

Bethlehem supplies every type of Fastener

MANUFACTURERS' LITERATURE

canized and phenol fibre laminates, giving data for selection and ordering, recommended uses and design helps. (54)

Ceramic Laboratory Ware. The Thermal Syndicate, Ltd. Technical descriptions, specifications and prices of Vitreosil ware said to be superior to porcelain in some uses. (55)

Rubber Parts. Tyer Rubber Co., 4 pp, ill, No. 1c. Describes design and molding service for rubber parts specified by industry. (56)

Plastics Parts. United States Gasket Co., 48 pp, ill. Catalog describes properties and uses of Teflon, this company's various Teflon products, and also gaskets of various materials. (57)

Polyester Resins. U. S. Rubber Co., Naugatuck Chemical Div., 18 pp. Properties and applications of Vibrins, thermosetting polyester resins. Includes details on pressure laminating and casting. (58)

Thermoplastic. Van Dorn Iron Works Co., 16 pp. Technical data on properties, available forms, fabrications and applications of Lucoflex, a rigid polyvinyl chloride. (59)

Metal Parts • Forms

Precision Investment Castings. The Adapti Co., 4 pp, ill, No. C-2M. Close tolerances and stronger metals are among advantages listed of Adapti method of precision casting. (60)

Precision Castings. Alloy Precision Castings Co., 8 pp, ill. Describes frozen mercury process for close tolerance precision casting of parts to order. Shows number products. (61)

Aluminum Die Castings. Aluminum Co. of America. Book contains detailed technical information for effective design of aluminum die castings. (62)

Aluminum Extrusions. Aluminum Co. of America. Design potentials of extrusion process and cost savings in fabrication and assembly of extrusions explained. (63)

Aluminum Castings. Aluminum Industries, Inc., 4 pp, ill, No. 20-A. Describes facilities for the processing of aluminum castings from the design stage to the finished product to customer specifications. (64)

Stainless Steel Powder Parts. Amplex Mfg. Co., 1 p, ill. Information on bearings, finished machine parts and permanent filters made from stainless steel powders. (65)

Precision Investment Castings. Arwood Precision Casting Corp., 16 pp, ill. Informative article on precision investment castings. Includes table of alloys recommended as most adaptable for this process. (66)

Nonferrous Plaster Mold Castings. Atlantic Casting & Engineering Corp., No. 4. Describes production of copper-base and aluminum alloy "Atlanti-castings." (67)

Steel Tubing. Babcock & Wilcox, 4 pp, ill, No. TB344. Typical applications of B&W seamless or welded stainless, alloy and carbon steel tubing. Indicates types, shapes and sizes available. (68)

Electroplated Tubing. Bart Mfg. Corp. Catalog describes process used in producing pipe, tubing and fittings with electrodeposited nickel coating. (69)

Metal Diaphragms. Beryllium Corp., 4 pp, ill. Helpful facts about selection of material, tooling methods, heat treating and testing procedure of beryllium copper diaphragms. (70)

Welded Steel Tubing. Brainard Steel Co., Tubing Div., 8 pp, ill. Shows facilities for manufacturing welded steel tubing, its applications, fabrication and specifications. (71)

Stainless Steel Forms. G. O. Carlson, Inc., 4 pp, ill. Tank heads, large steel plates, tubing, sheets, forgings and billets, all of stainless steel, are shown as typical of the forms available from this company. (72)

Steel Castings. Continental Foundry & Machine Co., 32 pp, ill. Booklet presents 12 considerations that should be taken into account in buying steel castings. (73)

Stainless Steel Valves. The Cooper Alloy Foundry Co., 4 pp, ill, Vol. 1, No. 1. *Valve Topics* provides information on uses, application and detailed examination of specific valve problems confronting engineers and users of stainless steel valves and fittings. (74)

Fabricated Rings. Dresser Mfg. Div., 8 pp, ill. Generator frames, exhaust manifolds and alternator spiders are some of the illustrated applications of this firm's facilities for ring making. (75)

Forged Parts. Drop Forging Assn., 60 pp. "Metal Quality" gives detailed data on the effects of hot working metals, describing properties obtained, advantages and limitations. (76)

Centrifugal Cast Pipe. The Duraloy Co., No. 3150. Bulletin shows this company's facilities for producing centrifugal cast pipe and tubing. (77)

Magnesium and Aluminum Castings. Eclipse-Pioneer Div. Foundries, "Book of Facts" shows company's facilities for custom-making aluminum and magnesium castings. (78)

Stainless Tubing. Peter A. Frasse & Co., 12 pp. Data on machining seamless mechanical tubing, including recommendations for tool design. (79)

Laminated Metals. General Plate Div., Metals & Controls Corp., 4 pp, ill, No. 1a. Properties and uses of various laminated metals, including precious metals overlays and laminated silver contacts. (80)

Fabricated Metal Parts. Graver Tank & Manufacturing Co., Inc., 4 pp, ill. Facilities provided by this firm for designing and producing metal parts of stainless steel, nickel, aluminum and other metals. (81)

Gray Cast Iron. Gray Iron Founders' Society, Inc. Booklet gives mechanical and engineering characteristics of gray cast iron. Includes details for designing cast components. (82)

Investment Castings. Gray-Syracuse, Inc., 4 pp, ill. Various parts of precision-cast brass, bronze, beryllium copper and steel. (83)

Perforated Materials. The Harrington & King Perforating Co., No. 62. Catalog gives data on fabrication methods, how to order, types of perforation and uses of perforated materials. (84)

Perforated Metals. Hendrick Mfg. Co., 4 pp, ill. Examples of perforated metal applications and various available perforation types. (85)

Die Castings. The Hoover Co., Die Castings Div. Describes die casting, gives essential design data, including draft, tolerance and wall thickness and core size requirements. (86)

Permanent Magnets. Indiana Steel Products Co., 34 pp, *Permanent Magnet Manual* No. 3. Uses, types and materials of permanent magnets. Includes design data. (87)

Helical Compression Springs. Instrument Specialties Co., Inc., 2 pp, ill. How to obtain economical assortment of 1100 beryllium copper compression springs for development work. (88)

Investment Castings. Investment Casting Co., 12 pp, ill. "Investment Casting" describes process for precision casting of intricate close tolerance parts in difficult-to-machine metals and shows advantages. (89)

Precision Cast Parts. The Jelrus Co., Inc. Advantages of centrifugal precision casting for custom manufacture of complex parts accurately and quickly. (90)

Bearing Design. Johnson Bronze Sleeve Bearing Headquarters. Data sheets give information on proper design of bearings, including details such as the lubrication of sleeve type bearings. (91)

Cemented Carbide Parts. Kennametal Inc., 72 pp, ill, No. 51. Characteristics of Kennametal compositions, design suggestions for their use, and descriptions of numerous standard parts. (92)

Powdered Metal Parts. Keystone Carbon Co., Inc., 36 pp, ill. Describes successful applications of powder metallurgy, gives data on correct design of powdered metal parts, and detailed information on powdered metal bearings. (93)

Metal Rings. King Fifth Wheel Co. Catalog and capacity charts of this company's facilities for bending and welding metal rings for industrial purposes. (94)

Pressed Parts. Lenape Hydraulic Pressing and Forging Co. Catalog shows numerous parts press formed by this company illustrating the kinds of jobs this firm can perform. (95)

Deep-Drawn Shapes. Linde Air Products Co. Complete information on Presto-O-Lite deep-drawn shapes and shells, including applications and design aids. (96)

Die Castings. Madison-Kipp Corp., 32 pp, ill. Describes company's aluminum and zinc die castings. Also shows Kipp Feather-weight air grinder and Fresh Oil lubricators. (97)

Powder Metal Parts. Metals Refining Co.,

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Div. of the Glidden Co., 16 pp, ill. Describes fabrication of iron, copper and lead powder metal parts, and discusses limitations and advantages of powder metallurgy. (98)

Plastic Coated Metal Tubing. Samuel Moore & Co., 4 pp, ill, No. F-2008. Describes properties, fabrication, available forms and fittings of Dekoron, plastic coated metal tubing with numerous uses. (99)

Powdered Metals. The New Jersey Zinc Co., 4 pp. ill, Vol. 3, No. 1. *Metal Powder Press* shows numerous ways in which metal powders are being used to cut fabrication costs of metal parts. (100)

Precision Casting. Ohio Precision Castings, Inc., 12 pp, ill. Numerous examples of industrial applications of this company's brass, bronze, aluminum and beryllium copper plaster mold castings. (101)

Seamless Tubing. The Ohio Seamless Tube Co., 12 pp, ill. Shows difference between such tubings as mechanical seamless, aircraft seamless, resistance welded and forged, listing advantages and applications. (102)

Mechanical Steel Tubing. Pittsburgh Tube Co., 44 pp, ill. Detailed information on characteristics, physical properties, fabrication and specifications of this firm's butt welded tubing. (103)

Perforated Metal Products. Pittsfield Products, Inc., 2 pp, ill. Describes this company's facilities for fabricating wire cloth and perforated metal products. Includes several applications. (104)

Bushings. Randall Graphite Bearings, Inc., 12 pp, ill, No. 100. Complete price list of bronze bushings and specially grooved bushings; specifications of bored and solid bronze bars. (105)

Electric Welded Pipe. Republic Steel Corp., 20 pp, ill, No. ADV-521. Detailed description of manufacturing process, advantages, structural and mechanical applications on pipe made by electric resistance weld method. (106)

Rigidized Metal. Rigidized Metals Corp., 8 pp, ill, No. CF1. Shows advantages of using rigidized stainless sheet metals in place of other sheet. Shows several available patterns, indicates many uses. (107)

Steel Castings. Steel Founders' Society of America, 920 Mildand Bldg., Cleveland, 36 pp, ill. Case histories illustrate versatility, strength and dependability of steel castings. Address requests to F. Kermit Donaldson, c/o the Society.

Powder Metal Parts. F. J. Stokes Machine Co., 4 pp, ill, Vol. 4, No. 1. Describes greatly expanded facilities for producing powder metal and molded plastic parts, other technical products. (109)

Alloyed Gray Iron Castings. Superior Foundry, Inc., 8 pp, ill. Gives advantages, specifications, and illustrates production methods of Superior's electric furnace process for producing alloyed gray iron castings. (110)

Small Tubing. Superior Tube Co., No. 31. Describes facilities for custom fabricating seamless or welded tubing of all analyses in sizes up to 5/8-in. O.D. (111)

Spun Metal Parts. Roland Teiner Co., Inc., ill, No. 51D. Brochure describes this company's facilities for spinning practically any metal or gage required. (112)

Stainless Tubing. Trent Tube Co. *Trentweld Data Bulletin* describes Trentweld stainless steel tubing, machine formed and welded in wide range of sizes. (113)

Formed Tubing. Tube Reducing Corp., 4 pp, ill. Stresses economic advantages of hot-forming complex tubular parts in the plant in which the precision tubing is made. Describes this company's facilities. (114)

Steel Castings. Unitcast Corp., 2 pp. Gives specifications of T-Loy 34, analysis, properties and common uses. (115)

Coatings • Finishes

Protective Coatings. American Chemical Paint Co., 8 pp, ill. Reference list describes purpose, characteristics, advantages and effectiveness of ACP metal protective chemicals and processes. (116)

Chemical Dip Finishes. Enthone Inc. Bulletin on Ebonal "C" and check list of Enthone literature on over 60 products and processes for electroplating and metal finishing. (117)

Lacquer Applications. Hercules Powder Co., Cellulose Products Dept., 6 pp. Booklet summarizes progress made to date, in terms of products, advantages, of lacquer as a protective coating for military requirements. (118)

Protective Coatings. R. M. Hollingshead Corp., ill. Folder describes Klad Kote corrosion preventives, gives detailed specifications, uses, description and other data in tabular form. (119)

Clear Lacquer. Maas & Waldstein Co., No. 110. Recommends Dulac Clear Universal Lacquer No. 462 for good adherence and retention of desirable surface qualities. (120)

Black Oxide Coating. The Mitchell-Bradford Chemical Co., 4 pp, ill, No. MB-3. Six advantages of Black Magic (Type A) Black Oxide coating process for steel and iron. (121)

Wrinkle Finishes. New Wrinkle, Inc., ill. Folder shows typical products utilizing Wrinkle finishes. (122)

Protective Coatings. Nox-Rust Chemical Corp., 2 pp, ill. Describes Nox-Rust 626 and 607 protective coatings for metal parts. Also includes comparison chart of recommended uses, film and liquid characteristics and application. (123)

Phosphate Coating. Parker Rust Proof Co., 11 pp, ill, No. A1922. Describes Bonderite corrosion resisting paint base, its advantages and applications. (124)

Corrosion Resistant Cement Coating. Pennsylvania Salt Mfg. Co., 1 p, ill, No. S-561. Step-by-step procedure in applying corrosion resistant cement over steel gridwork. (125)

Methods and Equipment

Heat Treating • Heating

Case-Hardening Process. American Gas Furnace Co. Principles of "Ni-Carb" case-hardening, its advantages, and descriptions of AGF furnaces for the process. (126)

Furnace Heating Elements. Carborundum Co., Globar Div. Complete data on Globar silicon carbide heating elements, said to be efficient, safe and easy to repair. (127)

Heat Treating Slide Indicator. Carpenter Steel Co. Indicates heat treatments recommended for various tool and die steels and effects of drawing temperature on hardness. (128)

Radiant Glass Panels. Corning Glass Works, 8 pp, ill, No. B-86. Uses and features of Pyrex glass panels coated with electrically conducting coating for radiant heating and drying. (129)

Heat Treating Furnaces. The Electric Furnace Co., 4 pp, ill. Shows various gas, oil and electric furnaces for annealing and heat treating requirements and lists applications. (130)

Porcelain Enamel Furnaces. Ferro Enamel Corp., 35 pp, ill. Discusses special oven design features and advantages and describes seven basic types of ovens and dryers, their uses and characteristics. (131)

Electric Furnaces. Harper Electric Furnace Corp., 4 pp, ill. Descriptions of various high temperature electric furnaces for special applications and electric tunnel kilns for processing ceramics. (132)

Furnace Flow Control Valves. Hauck Mfg. Co., 4 pp, ill, No. 704A. Describes Micro-Cam oil valves for metering oil flow to industrial heating equipment, including specfications. (133)

Atmosphere Generator. Hevi Duty Electric Co., 2 pp, ill, No. IND-1147-CR. Use, construction and specifications of this company's "Atmo-Gen" units. (134)

Carbo-Nitriding Furnaces. Holcroft & Co., 4 pp, ill. Features, advantages and operation of this firm's case hardening equipment. (135)

High Frequency Heating Units. Lepel High Frequency Laboratories, No. MM-7. Specifications, features and advantages of this company's low cost, high frequency heating units. (136)

Induction Heating Units. Lindberg Engineering Co., No. 1440. Descriptions and applications of this firm's induction heating units said to give rapid, dependable operation on large or small parts. (137)

Induction Heating. Loftus Engineering Corp. Advantages and special applications of induction heating furnaces. Also includes diagramed chart of general specifi-

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cations and dimensions of single coil-type unit. (138)

Induction Heating Furnace. Magnathermic Corp., 6 pp, ill. Features, applications and description of this company's low frequency heating furnaces claimed to be well-suited to extrusion processes. (139)

Air Compressors. The Spencer Turbine Co., 12 pp, ill, No. 126-A. Performance curves, capacity tables and detailed descriptions of Turbo Compressers for use in gas or oil fired heat treating equipment. (140)

Heat Treating Accessories. Stanwood Corp. 16 pp, ill, No. 16. Describes variety of heat treating accessories, including baskets, retorts and carburizing boxes. (141)

Heat Treating Equipment. Sunbeam Corp., Sunbeam Steward Industrial Furnace Div., 4 pp, ill, Vol. 10, No. 6. *Metal Minutes* shows various applications of this company's equipment in user's plants. (142)

Batch-Type Furnaces. Surface Combustion Corp., No. 50-E. Description and advantages of this company's Allcase batch-type furnaces. (143)

Induction Heaters. Westinghouse Electric Corp., 12 pp, ill, No. B-4782. Case histories showing applications, advantages and versatility of this company's equipment for induction heating. (144)

Heating Units. Edwin L. Wiegand Co., No. 50. Catalog describes this company's industrial heating units, giving specifications and features. (145)

Cleaning • Finishing

Belt Grinders and Finishers. Behr-Manning. Bulletin describes advantages of belt finishing and grinding, shows this company's equipment and suggests methods for cost cutting. (146)

Metal Cleaner. The Diversey Corp., 4 pp, ill, No. 49A. Advantages of Diversey No. 909 heavy duty tank cleaner, said to be non-caustic, yet exceptionally powerful. (147)

Diamond Abrasive. Elgin National Watch Co., 8 pp, ill, No. 5000651. Features, advantages and helpful data for selection of Elgin Dymo-C diamond abrasives. (148)

Burring Metals. The Lea Mfg. Co., 6 pp. Standard practice for ferrous and nonferrous metals, also instructions as to which wheel and compound to use in burring. (149)

Flame-Spraying Plastic Coating. Linde Air Products Co., 8 pp, ill, No. F-7789. Equipment, plate preparation, application technique and safety precautions for flame-spraying polyethylene plastic. (150)

Vapor Degreasing. Manufacturers Processing Co., 2 pp, ill. Explains briefly operation of new Bar-L degreaser, for cleaning small parts in shop, production line or maintenance department. (151)

Steel Cleaners. Neilson Chemical Co., Nos. 45-34 and 50-37. Complete data on wipe-off type, dip type and rust removing cleaners for steels. (152)

Barrel Finishing Media. Newton Industries Inc., 4 pp, ill. Describes advantages of Polishapes, zinc alloy bodies specially designed for use in barrel finishing processes. (153)

Metal Cleaner. Oakite Products, Inc., 5 pp, No. 7993. Oakite Compound No. 33 said to combine oil removal, rust removal and paint preparation into one operation. (154)

Drum Cleaning. The Pangborn Corp., 6 pp, ill, No. 220. Brochure explains Roto-blast technique in cleaning drums and covers. Also includes safeguards, specifications and diagrams on operation. (155)

Metal Cleaner. Philadelphia Quartz Co., ill, No. 33-4. Describes Metso 66 soluble silica heavy duty alkali metal cleaner, with brief recommendations for use. (156)

Industrial Brushes. Pittsburgh Plate Glass Co., Brush Div., Dept. W-4, 3221 Frederick Ave., Baltimore, Md. Case histories indicate economies available to users of Pittsburgh brushes. Request on company letterhead direct from this company.

Mechanical Finishing. Roto-Finish Co. Folder describes uses and economies of Roto-Finish tumbling-type equipment for precision grinding, deburring and coloring metals. (157)

Tumbling Barrels. Tumb-L-Matic, Inc., 2 pp, ill, No. XL-48. Features and specifications of Lupomatic wet process tumbling barrels for deburring and cutting down metal parts. (158)

Hard Chromium Plating Unit. Ward Leonard Electric Co., 4 pp, ill. Features of Model A-20 Chromaster industrial hard chromium plating unit, description of process and Chromasol solution. (159)

Welding • Joining

Hard Facing Alloy Electrodes. Alloy Rods Co., 16 pp, ill, No. 5651. Explains characteristics, properties and typical applications of basic hard facing alloys manufactured by this company. (160)

Brazing Alloys. The American Platinum Works, 46 pp, ill. Handy sized manual gives detailed description of the brazing process, the alloys used, design of joints and other considerations for successful joining. (161)

Low Hydrogen Welding Electrodes. Arcos Corp., No. 45118. Folder contains questions and answers on low hydrogen electrodes, selector chart for welding high strength steels, and specification data on the new Tensilend electrodes. (162)

Bonding Resins. Ciba Co., 4 pp, ill. Properties of new group of resins, their applications as adhesives for metals and nonmetallics, molding and coatings. (163)

Welding Eelectrodes. Eutectic Welding Alloys Corp., 15 pp, ill. Booklet contains chart of over 100 different welding alloys, their main uses, bonding temperatures and tensile strengths. (164)

Solder. Federated Metals Div., 36 pp, ill. Data on the selection of solders for specific applications, their properties and their use. Tells the role of fluxes and how to prepare the work. (165)

Brazing. Handy & Harman, ill, No. 54. *Brazing News* describes applications and developments of Easy-Flo and Sil-Fos low temeprature silver brazing alloys. (166)

Stainless Steel Fasteners. H. M. Harper Co., 56 pp, ill. Price list and stock book covering complete line of this firm's nonferrous and stainless steel fastenings. (167)

Special Fasteners. John Hassall, Inc. Complete line of cold-headed nails, rivets and screws from 1/32- to 3/8-in. dia up to 7-in. lengths in a variety of finishes. (168)

Brass and Bronze Fasteners. The Jacques Co., 26 pp, ill, No. 50. Price lists and specifications of this firm's fasteners, including various nuts, cap screws, bolts and washers. (169)

Stud Welding. KSM Products, Inc., 27 pp, ill. Booklet explains correct use of stud welding equipment and outlines steps and procedures to be followed. (170)

Hidden-Arc Welding Equipment. The Lincoln Electric Co., No. 1303. Data on Manual Lincolnweld high-current-density hidden-arc welding equipment said to enable more efficient welding. (171)

Resistance Welding. P. R. Mallory & Co., Inc., over 500 pp, ill, price $3.00. Data book contains photographs, charts, tables and diagrams of up-to-date welding information, also recommended practices and standard methods for testing. (172)

Welding Stainless Steels. The McKay Co., 23 pp, plus chart. Practical questions and answers to help overcome difficulties in welding stainless steel. Chart gives data on each McKay electrode in chart. (173)

Induction Brazing. The Ohio Crankshaft Co. "Typical Results of Tocco Induction Brazing and Soldering" shows by case histories the advantages of these fastening methods. (174)

Fasteners. The Palnut Co., 4 pp, ill. Advantages, principle of operation and dimensional data on Palnut's coil tube fasteners and shield can fasteners. (175)

Welding Positioners. Ransome Machinery Co., Industrial Div., 36 pp, ill, No. 210 C. Description, features and applications of 100- to 40,000-lb capacity welding positioners. (176)

Special Fasteners. South Chester Corp., Southco Div., 6 pp, ill, No. SCO 12. Descriptions and specifications of special fasteners for unique fastening applications. (177)

Carbon Arc Welding. Speer Carbon Co., 8 pp, ill. Advantages of carbon arc welding for fabricating and repairing alloy and nonferrous metals. (178)

Self-Locking Nuts. Standard Pressed Steel

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Co., ill. Features and applications of Flexloc locknuts, listing prices and specifications of popular sizes. (179)

Special Fasteners. The Townsend Co., 4 pp, ill, No. TL-63. Descriptions and advantages of Nylok Locknuts and Tufflock Nuts including specifications and available finishes. (180)

Resistance Welding Control. Westinghouse Electric Corp., No. B-4309. Advantages, features and specifications of this company's resistance welding control apparatus. (181)

Forming • Casting • Molding Machining

Bonded Abrasives. The Carborundum Co., 48 pp, ill, No. 3. Properties and performance characteristics of MX bonded abrasives. Shows various abrasive products and applications. (182)

Tool and Die Milling Machine. Cincinnati Milling Machine Co., 19 pp, ill, No. M-1731. Features, design and applications of die milling machines. (183)

Moly-Sulfide Lubricant. Climax Molybdenum Co., 40 pp. Detailed tables of applications of moly-sulfide lubricant in the manufacturing plant, the job shop, and in the field, indicating form used, and results of application. (184)

Press Brake Dies. The Cyril Bath Co., 48 pp, ill, No. D-50. Catalog shows wide variety of press brake dies for curling, bending, offsetting, channel bending and other forming operations on metals. (185)

Machining Hard Metals. The Method X Co., 4 pp, ill, No. SA1018. Features, operation, tolerances and applications of new machine said to facilitate fabrication of sintered carbides, S-816, etc. (186)

Automatic Molding Machines. F. J. Stokes Machine Co., 20 pp, ill. Describes development, advantages and applications of fully automatic molding machines for thermosetting plastics. (187)

Plastics Molding Press. F. J. Stokes Machine Co., 4 pp, ill, No. 503. Description and specifications for automatic plastics press. Typical products shown. (188)

Machining Laminated Plastics. Synthane Corp., 6 pp, ill. Recommended techniques for common machining operations on laminated plastics. Includes properties and design hints. (189)

Drilling Machine. Wales-Strippit Corp. 8 pp, ill, No. DM. Describes features, setting up, operation and accessories of Wales drilling machine, designed for precision location of holes. (190)

Aluminum Extrusion Presses. Watson-Stillman, ill, No. 340-A. Describes this company's light metals extrusion presses of 500- to 5,000-ton capacities, their features and advantages. (191)

Metal Forming Facilities. R. D. Werner Co., 4 pp, ill. Explains relative merits of cold roll forming and extruding light metal shapes. Shows company's facilities for both types of fabrication. (192)

Magnetic Perforating Dies. S. B. Whistler & Sons, Inc., ill. Complete descriptions and applications of this company's magnetic perforating dies. (193)

Inspection • Testing • Control

Laboratory Reagents. Allied Chemical & Dye Corp., General Chemical Div., 40 Rector St., New York City, 264 pp, ill. Complete buyer's guide for users of laboratory reagents and chemicals. Includes such pertinent facts as grades, strengths and maximum limits of impurities. Request direct from Allied on company letterhead.

Testing Machine. Baldwin-Lima Hamilton Corp., 4 pp, ill, No. 336. Bulletin presents design features, operation and specification of new Sonntag Model 12-H Universal testing machine. (194)

Laboratory Microscopes. Bausch & Lomb Optical Co., 24 pp, ill, No. D-185. Descriptions and specifications of various microscopes for such uses as metallurgical microanalysis. (195)

Metallograph. Bausch & Lomb Optical Co., 20 pp, ill, No. E-232. Features of Balphot metallograph for microscopic examination of metallographic specimens. (196)

Films for Surface Analysis. The Brush Development Co., ill, No. 653. Applications of, and equipment for using Faxfilm for microscopically examining surfaces of various materials. (197)

Hardness Testers. Clark Instrument Inc., 4 pp, ill. Shows features of this firm's hardness testers and discusses their accuracy, speed of operation and durability. (198)

Photoelastic Stress Analysis. Eastman Kodak Co., 16 pp, ill, Price 35c. Booklet briefly discusses photoelastic stress analysis as a method of solving problems of stress distribution. (199)

Gas Analysis. Charles Engelhard, Inc., 8 pp, ill, No. 800 A. Example solutions of gas analysis problems using this company's equipment. Said to give complete sensitive analysis. (200)

Air Classifier for Dense Materials. Federal Classifier Systems, Inc., 4 pp, ill. Description, specifications and advantages of air classifying units for classifying dense powders according to particle size. (201)

Temperature Controls. Claud S. Gordon Co., 4 pp, ill. Brief description and advantages of straight line, fully automatic temperature control. (202)

Fatigue-Testing Machines. Krouse Testing Machine Co., 10 pp, ill, No. 46-B. Describes company's plate and sheet fatigue testing machines, including specifications and testing data. (203)

Pyrometer Controller. Loudon Instruments, Inc., 5 pp, ill. Brief description of pyrometer controller for precise temperature control without a chart record. (204)

Time-Temperature Control. Minneapolis-Honeywell Regulator Co., Brown Instruments Div., 13 pp, ill, No. 6020. Shows features, design characteristics and specifications of cam programmer thermometers. (205)

Compression Tester. National Forge and Ordnance Co., 2 pp, ill, No. 492. Description, features and uses of sensitive, sturdy, low-capacity-compression-crust testing machine. (206)

Spectrographs. National Spectrographic Laboratories, Inc., 4 pp, ill, No. 300. Description, operating principle and control features of spectrograph units for both quantitative and qualitative analysis. (207)

Testing Machines. Tinius Olsen Testing Machine Co., 8 pp, ill, Vol. 5, No. 1. *Tinius Talks* describes various testing machines, their features, applications and advantages, discusses testing techniques. (208)

Radiation Pyrometer. The Pyrometer Instrument Co., No. 100. Features and principle of Pyromradiation pyrometer for obtaining spot temperatures in furnaces, kilns, forgings and fire boxes. (209)

Universal Testing Machines. Riehle Testing Machines Div., 6 pp, ill, No. RU-3-50. Features, specifications and descriptions of Model MA hydraulic universal testing machines. (210)

Tensile Testing Machines. Scott Testers, Inc., 6 pp, ill, No. 50. Shows wide assortment of testing machines for testing tensile strength of materials such as rubber, paper, wire and thread. (211)

Thermocouples. Thermo Electric Co., Inc. Catalog Section 22 G shows this firm's line of thermocouples and accessories for numerous industrial uses. (212)

Plastics Tests. U. S. Testing Co., Inc., 2 pp. Price list of physical, chemical, microbiological and permanence tests available for plastics film, sheeting and coated fabrics. (213)

Recording and Control Instruments. Wheelco Instruments Co., 3 pp, ill, No. Z6700. Condensed catalog lists typical instruments manufactured by this company, with brief description of each. (214)

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General

High Vacuum Pumps. Distillation Products Industries. Data on high vacuum pumps of unique design for such uses as metal processing and dehydration. (215)

Casting Reclamation. Tincher Products Co., 24 pp, ill. Covers most frequently asked questions regarding Tincher's process for reclaiming rejects due to porosity in castings. (216)

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The Editor's Page

A Plea for Research

Last month on this page we commented on the verbosity of OPS orders coming from Washington and compared a "typical" report with other historic writings. A correspondent raises a point: "Did I see and carefully estimate the word count of the report?" The answer is no, I relied on the usually reliable source. However, it is agreed that there is too much verbosity in most government regulations. Just a casual glance at some of the NPA regulations shows that such items as deerskins are controlled by 1,445 words; tungsten, 3,068 words; and bismuth, 3,596. These are just the original orders, to say nothing of the supplementary orders which come out later. However, we promise to be more cautious in the future and count OPS orders as well as those from NPA.

An Armchair Tour

Recently stockholders of Foote Mineral Co. and members of the press were taken on a tour of some of the company's operations in widely scattered points without leaving their comfortable seats in the company cafeteria. This was done by means of a closed-circuit television set-up. Using both live and filmed segments, the video presentation showed many of the processes involved in extracting lithium and zirconium. As an industrial first, everyone agreed, this was a worthwhile undertaking.

A Dark Cloud

You would think that everything would be sunny for the aluminum people, with countless government officials recommending to one and all that they shift from copper to aluminum wherever possible. However, the recommendations are viewed with somewhat less than complete enthusiasm by the aluminum people who can foresee a wild rash of misapplications which could cause later repercussions. Their attitude is mild, though, compared to that of the copper people who protest that the government is painting a much darker picture than is warranted by the facts. As a matter of fact, many metal suppliers feel that the need for controls on metal use has passed and state that if a free market were to return, there is a likelihood that some metal prices would come down. Within the space of a few months we have seen the supplies of some metals change from critically short to ample. Now that the defense production timetable has been extended, there could be a great change in other materials within a matter of weeks.

Pats on the Back

Last month, as you may know, we ran a long special report on plastics as alternate materials. Naturally, when we do something of this kind, we are hopeful that it will be well received. Apparently this has been, for numerous phone calls and letters have told us so. However, an unexpected reaction occurred. One phone call was from a top editor of a magazine which specializes in plastics. He reported: "Our entire staff has carefully studied the article and cannot find one valid criticism. You are to be congratulated." That coming from a publishing colleague made us feel good.

How Time Flies

It seems only yesterday that Dagmar was named "Miss Welder". But now we have a new reigning queen. Denise Darcel has ascended to the throne to rule for 1952. This honor was accorded Miss Darcel by the National Eutectic Welder's Clubs for, according to the citation, "outstanding qualities of beauty, physical charm, poise, determination, endurance, meticulousness, emotional stability, ready wit and unselfishness." Now we sadly take down Dagmar's photograph and replace it with that of the new weldress, or temptress. It's a thing like this that makes an editor's life so complex.

Next Month

In laying out our editorial program months in advance, we tried to schedule for this period articles which would suggest wider applications for certain materials not universally used for mechanical parts. That is why we scheduled a comprehensive report on the use of carbon and graphite for such parts. Even though scarcities have abated in some materials that were somewhat short, there is still ample reason for you to look at this article. Carbons and graphites have a wide range of properties that suit them for many applications involving wear, corrosion and other difficult conditions. We think you'll find it interesting.

T. C. DuMond
Editor